

GENERATION & NETWORK

Numerical Motor Protection

DIGITAL CONVERSATIONAL MOTOR PROTECTION RELAYS IN MODULAR CASE IMM 7000

IMM7000



IMM 7960 and IMM 7990 relays have been specifically designed to provide electrical protection for high and medium voltage motors, as well as high power motors at low voltage.

Of modular conception, they form an overall system with PROCOM architecture or can be used separately in all other classic protection schedule by transmitting all the data they possess (alarms and trips, together with operating quantities, and on request from the operator both operating quantities and relay settings) and on the other hand, they can receive specific instructions during starting or reacceleration sequences.

These devices incorporate in one small plug-in case all the functions necessary for sophisticated protection of all types of ac motors.

The main principles are those of the ITM series of relays which protect tens of thousands of high and medium voltage motors and have proved their worth for more than 20 years. Their design, based on integrated circuit technology around a microprocessor, provides:

- the incorporation of additional functions,
- higher precision and ease of adjustment as well as assistance to the user by giving, via a digital display, the following information:
 - the setting values,
 - the real start characteristics of the motor,
 - the thermal state and the load current,
 - the type and amplitude of a fault which has caused a trip.

L'IMM 7960 has a trip output and a start authorisation output.

L'IMM 7990 has in addition an alarm output.

Protection functions

- Thermal overload [49], with two time-constants
- Thermal pre-alarm (IMM 7990 only)
- Start authorisation by detection of the thermal state [0d]
- Limitation of number of starts [66] (IMM 7990 only)
- Too long start
- Locked rotor [51LR]
- Short-circuit [50]
- Unbalance - Loss of one phase [46]
- Earth/ground fault [50N/51N]
- Detection of pump un-priming [37]

Options

C.E.E.'s unique experience in the field of motor protection has enabled us to define all of the standard protection functions described above as well as more than 20 special functions to provide the correctly adapted solution to specific problems. These special functions are chosen when ordering from the options given in figure 1.

Major advantages

- The very wide current setting ranges, together with a low burden can ensure protection of a very varied range of motors with a limited number of different current transformer ratios.
- Perfect protection of the machine during the starting period (a special unit with an extremely inverse curve).
- Possibility of motor reacceleration after a network fault, as the relay takes account of short-duration network loss.
- Start-up authorised only when the thermal state of the machine will allow it, and the relay auxiliary supply is present.
- Highly sensitive earth/ground fault unit when used with a core-balance CT.
- Easily mounted: small dimensions and well-proven plug in system.
- Simple high-precision settings: adjustments by switches and potentiometers (thus avoiding any risk of loss of information and direct read-out on the digital display).
- Read-out on the relay of the type of fault and its amplitude after a trip.
- Permanent load current indication if required.
- Able to communicate via a serial digital link.
- Professional electronic components.

Description of the protection functions

Thermal overload [49]

The IMM 7000 relays create a thermal image of the motor from an appropriate blend of the positive and negative sequence components of current to take into account the increased thermal effects, particularly in the rotor, under unbalanced supply conditions.

This thermal image has two time-constants:

- the first, τ , adjustable from 4 to 32 minutes on the relay faceplate, comes into effect as soon as the motor is connected to the network,
- the other, τF , may be fixed on request at 2, 4 or 6 times the values of τ .

Time-constant τF comes into operation in the thermal image as soon as the current absorbed by the machine drops below 15% of nominal, thus indicating that the motor is disconnected from the network. Under these conditions, as the motor slows the cooling system becomes less efficient and causes an apparent increase in the motor's timeconstant. Figure n° 5 shows the curves corresponding to different preload conditions for one particular time-constant τ (12 minutes).

It will be noted that the curves show a discontinuity at approximately 3 times setting. This is in order to produce a true thermal protection for overload situations, whilst avoiding false tripping under starting conditions.

Thermal pre-alarm (IMM 7990 only)

A separate output unit (A) provides an alarm as soon as the thermal state of the motor is above 80% or 100% of nominal state.

It should be noted that under balanced supply conditions, the thermal unit set at Ith will trip for a permanent current of 1.07 Ith which corresponds to 114% of the nominal thermal state.

Start authorisation unit

Whenever the thermal state of the motor is such that its protection would not allow a further start sequence to be carried out, it would be detrimental to the machine to switch it on, only to have the relay follow this with a tripping signal.

To avoid such manoeuvres, the IMM 7000 relays contain a unit (D) whose contact may be inserted into the closing coilchain. This unit will prevent the closing order being carried out whilst the thermal state of the motor is above that which would allow a successful starting sequence (40, 60, 80 or 100% of the nominal thermal state).

Unit to limit the number of starts [66] (IMM 7990 only)

This function uses a counter to control the number of starts in a certain time: a chosen number of starts is permitted during a chosen reference period (t). If this number of starts is attained, any new start is prevented for a further period (T).

This function operates the output unit D mentioned in the paragraph «Start authorisation unit».

Too long start and locked rotor whilst running [51 LR]

As well as being covered by the thermal protection, each starting sequence is individually monitored in order to check that the heating effect is not significantly above that defined by the parameters Id and Td set on the relay.

To do this, the relay incorporates an extremely inverse time unit ensuring efficient protection of the motor against abnormally long starting periods, which is independent of the network voltage.

After the starting period, the locked rotor or stalling situation is covered by an independent (or definite) time overcurrent unit.

Short circuit protection [50]

Protection against short-circuits or very heavy phase-to-phase faults is ensured by the high speed positive sequence unit. The adjustment of this unit is derived automatically from the settings used for the starting characteristics.

It may be put out of service (by a switch on the faceplate) whenever the motor is controlled by a fuse/contactors unit.

Protection against unbalance and loss of phase [46]

This unit operates on the negative sequence component of current. Its operating curve (figure n° 6) is of the dependent time type, thus avoiding maloperation on unbalance which could be caused by the CTs during starting or reacceleration periods, whilst at the same time ensuring adequate protection. Its minimum operating time makes it compatible with fuse/contactors control.

Protection against earth/ground faults [50N/51N]

This unit may be connected to a core-balance CT or used in the residual connection of the 3 line CT's. In the latter case, the transient inaccuracy of the line CT's during the starting or the reacceleration periods may lead to «inadvertent» trippings of the protection.

To solve such problems, it is highly recommended to connect a stabilising resistor in series with the relay input (consult us).

Connection of the core-balance CT provides the very sensitive operating levels required to ensure protection in networks with high impedance earthing/grounding. The operating time is automatically increased when the positive sequence component is put out of service, which makes it compatible with fuse/contact control.

Protection against pump un-priming [37]

This undercurrent unit, driven from the positive sequence component, comes into operation when the motor current stabilizes at a value between 15% and 40% of nominal for more than 3 seconds, indicating a no-load condition characteristic of a pump becoming un-primed.

Data management

A major characteristic of the IMM 7000 is its ability to communicate with the outside world. It can in fact exchange information, both locally and to a remote location, in three main ways:

- a local digital display unit,
- a sophisticated arrangement of output units,
- a serial digital link which may be incorporated into a communication network PROCOM.

Digital display unit

The IMM 7000 are equipped with a digital display unit, giving local read-out of:

- the various relay setting adjustments,
- measured or calculated values: thermal state, positive, negative and zero sequence components of line current,
- starting quantities, memorised during the last start sequence,
- the type of fault having caused a trip,
- when relevant, the address of the relay in the communication network (see «Digital Communication Network»),
- the option according to which the relay has been manufacture (see figure 1).

Output units

The IMM 7000 incorporate several output relays giving all-or-nothing output signals:

- an electromechanical relay «T» with high-power contacts, operates for the tripping signals coming from each of the IMM 7000 protection functions. It has two output contacts, one of which is a change-over type, and a mechanical operation indicator visible on the front of the relay. This unit which is self-reset in the standard version, may be electrically held in and/or trip in a differentiated manner (see «Options»),
- an electromagnetic relay «A» with one output contact indicating a thermal pre-alarm (IMM 7990 only),
- an electromagnetic relay «D» with one output contact authorising motor starting according to settings defined by the operator.

The IMM 7990 has also an internal relay which can indicate presence of the auxiliary supply via the digital communication network.

Digital communication network

The IMM 7000 may be integrated into the digital data exchange network.

Each communication channel has two pairs, one for transmission, the other for reception. Data is exchanged via a 0-20 mA current loop at 1200 bauds on J-Bus®/Modbus® (consult us).

OPTIONS

<p>Negative sequence unit I↓> out of service.</p> <p>Locked rotor unit IL_r > out of service.</p> <p>Thermal unit out of service.</p> <p>Manual reset for all units.</p> <p>Manual reset for all units except the thermal unit.</p> <p>Zero sequence unit time delay tl₀ = 0.5 sec.</p> <p>Zero sequence unit time delay tl₀ = 0.25 sec.</p> <p>Negative sequence unit time delay tl > multiplied by 2 for 2 times the starting time Td.</p> <p>Negative sequence unit time delay tl > multiplied by 2.</p> <p>I↓> + IL_r > out of service.</p> <p>Manual reset for all units + I↓ out of service.</p> <p>Zero sequence alarm with or without thermal alarm..</p>	<p>Manual reset for all units + IL_r > out of service.</p> <p>Manual reset for all units except the thermal unit + I↓> out of service.</p> <p>Manual reset for all units except the thermal unit + IL_r > out of service.</p> <p>ti₀ = 0.25 sec. + Il > out of service.</p> <p>ti₀ = 0.25 sec. + IL_r out of service.</p> <p>ti₀ = 0.25 sec. + manual reset for all units except the thermal unit.</p> <p>tl↓ x 2 during 2 Td + IL_r > out of service.</p> <p>tl↓ x 2 during 2 Td + manual reset for all units except the thermal unit.</p> <p>tl↓ x 2 + IL_r > out of service.</p> <p>tl↓ x 2 + manual reset for all units except the thermal unit.</p>
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Fig. 1 - Options table

GENERAL CHARACTERISTICS

1 - Input/Output quantities

• Current

- Nominal values
- Burden
- Thermal withstand limits
- Recommended transformers

$I_n = 1 \text{ A}$ or 5 A .
 $F_n = 50 \text{ Hz}$ or 60 Hz .
 $< 0.5 \text{ VA}$ at I_n .
 $15 I_n$ for the operating time.
 $80 I_n$ for 1 sec.
 5 VA 5P10 (including 20 m of 4 mm^2 cable at $I_n = 5 \text{ A}$).
On residual connections: 3 CTs.
On core-balance CT : 2 CTs + CEE core-balance CT.
• 24 V (operating range 19 to 26.5 V).
• 48 V (operating range 40 to 58 V).
burden 3.5 W (48 V).
• $110\text{-}125 \text{ V}$ (operating range 80 to 140 V).
burden 8 W (110 V).
• $220\text{-}240 \text{ V}$ (operating range 160 to 275 V).
burden 17 W (220 V).
(Please consult us for ac auxiliary supply).

• Outputs

- Local signalling
- Electromechanical units automatic reset contact

By digital display, read-out of:
• setting values,
• measured or calculated quantities,
• type and value of fault having caused a trip.
T: trip $1\text{c/o} + 1\text{No}$.
A: Alarm 1 No (IMM7990 only).
D: start 1No .

• Possibility of hand-reset contacts for some units

(see «Options»)

• Hand-reset mechanical operation indicator

On «T» Unit.

• Contacts:

- maximum voltage
- maximum permanent current
- closing capacity (0.2 sec.)
- breaking capacity:
 - dc ($L/R = 40 \text{ ms}$)
 - ac ($\cos \varphi = 0.4$)

600 V .
 5 A .
 10 A .
 50 W ($1 \text{ A}/48 \text{ V}/\text{DC}\text{-}0.5 \text{ A}/110 \text{ V}/\text{DC}$).
 1250 VA ($I < 3 \text{ A}$).

2 - Measuring units

• Thermal overload

- Operating level
- Time constants
- Operating time
- Thermal alarm

$I_{th} = 0.4 - 1.2 I_n = K.K 1 I_n$.
Continuous adjustment using switch K and potentiometer K1.
 $1.07 I_{th}$.
 $\tau = 4 - 32 \text{ min.}$; cooling: $\tau F = 1\text{-}2\text{-}4\text{-}6$ on request.
See figures n° 4 and 5.
 $\theta > 80\%$ or 100% , nominal thermal state.

• Start authorisation

- By check on the thermal state
Authorisation for $\theta < \theta_d$
- By check on the number of starts (IMM7990 only):
Authorised
Prevented

By normally open contact of the «D» unit in series with the closing coil chain.

$\theta_d = 40 - 60 - 80 - 100\%$, of nominal thermal state.

$N = 1$ to 4 starts during $t = 15$ to 60 min .
During $T = 15$ to 60 min . if N attained during t .

GENERAL CHARACTERISTICS

<ul style="list-style-type: none">• Protection against too long starts<ul style="list-style-type: none">- Operating time	In service for a period of 2 Td from start initiation Extremely inverse time curve ($1^2t = \text{const}$) defined by: Td = 2 - 60 sec. Id = 3 - 10.5 lth.
<ul style="list-style-type: none">• Locked rotor protection<ul style="list-style-type: none">- Operating level- Operating time	Brought into operation 2 Td after start initiation 2.5 lth or 4 lth Fixed, on request 1 sec. or 4 sec. Fixed, on request
<ul style="list-style-type: none">• Short-circuit (positive sequence)<ul style="list-style-type: none">- Operating level- Operating time	Brought into operation by switch I >> in «ON» position 1.4 Id (limited to 12.5 lth) 0.08 sec. (at twice setting)
<ul style="list-style-type: none">• Unbalance and loss of phase (negative sequence)<ul style="list-style-type: none">- Operating level- Operating time	I↓ > = 0.2 or 0.5 lth Curve figure n° 6
<ul style="list-style-type: none">• Zero sequence<ul style="list-style-type: none">- Operating level (Ko) - Operating time	0.05 - 0.4 In (on line CTs) 1 - 8 A primary (on CEE core-balance CT). 0.1 sec. (switch I > > «ON») 0.25 sec. (switch I > > «OFF»)
<ul style="list-style-type: none">• Protection against pump unpriming<ul style="list-style-type: none">- Operating level- Time-delay	Operational on request. 0.15 lth < I < 0.4 lth ; fixed 3 sec., fixed.
3 - Nominal operating ranges	
<ul style="list-style-type: none">• Temperature• Frequency• Auxiliary supply• Storage range	-10 to + 50°C Fn ± 2.5 Hz See paragraph «Auxiliary supply» - 30 to + 70°C
4 - Insulation	
<ul style="list-style-type: none">• Dielectric withstand• Impulse withstand	2 kV - 1 min to IEC 255-5 5 kV peak - 1.2/50 µs to IEC 255-5
5 - High frequency interference	2.5 and 1 kV/1 MHz IEC 255-22-1
6 - Cases	
IMM 7960	R2
IMM 7990	R3 + external resistor for auxiliary supply > 48 V
7 - Weight	3.5 kg.
8 - Drawings to be used when ordering	
IMM 7960	25A4
IMM 7990	9987

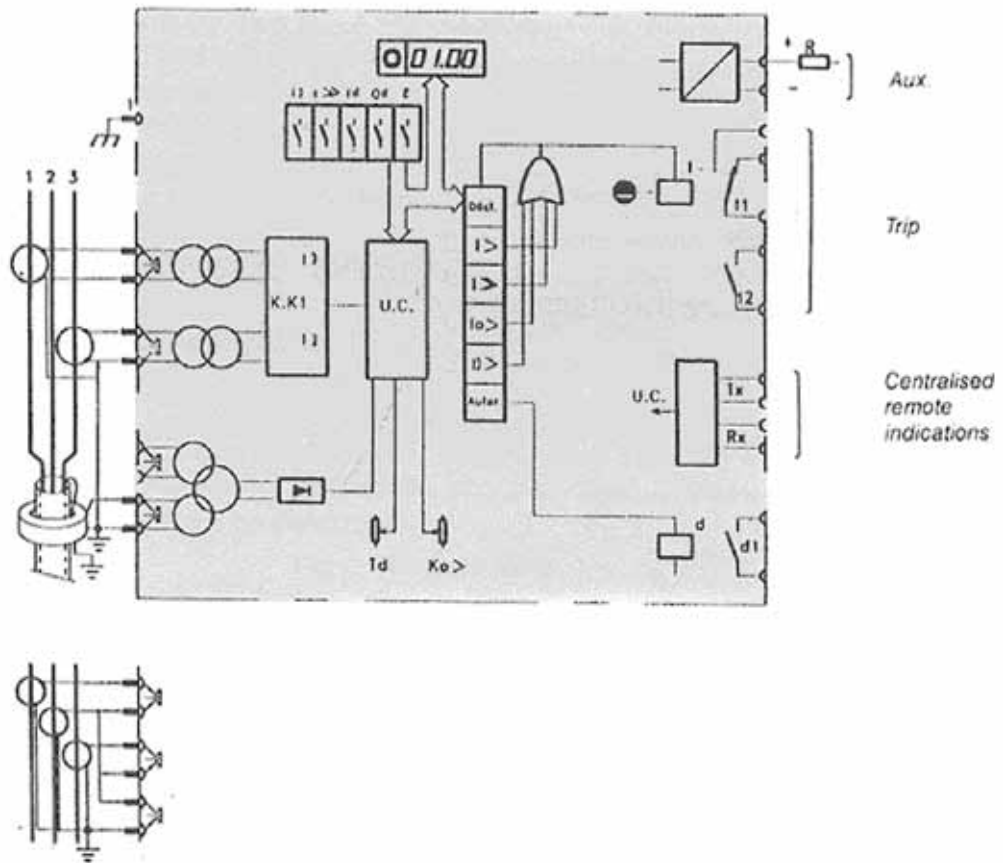


Fig. 2 - IMM 7960: Simplified operation and connection diagram

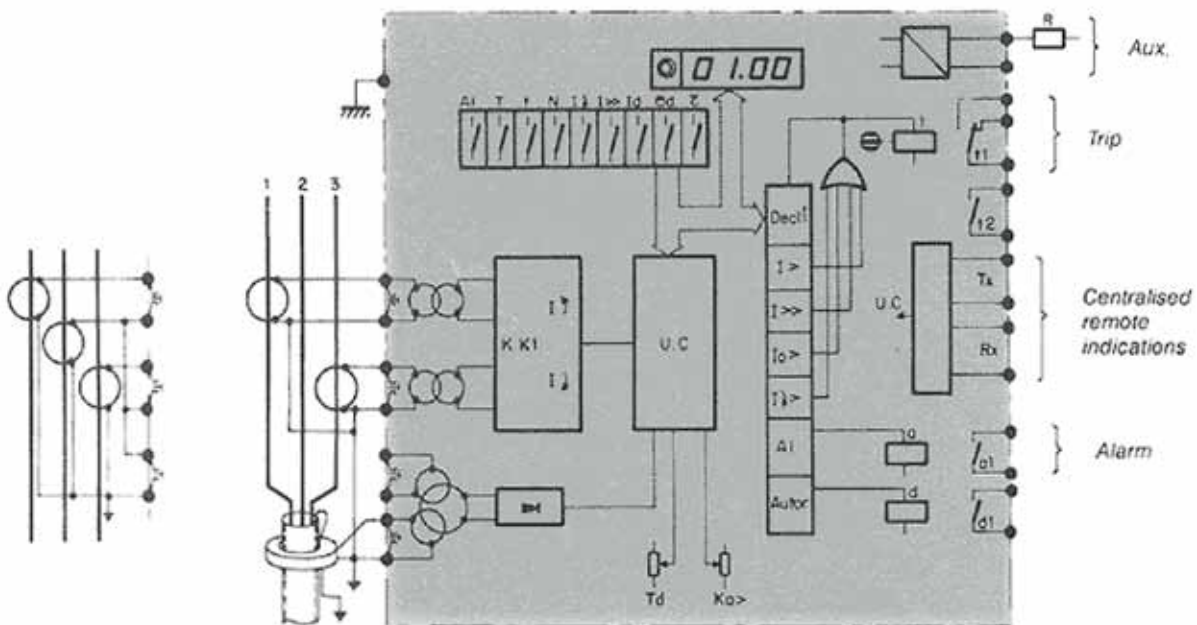
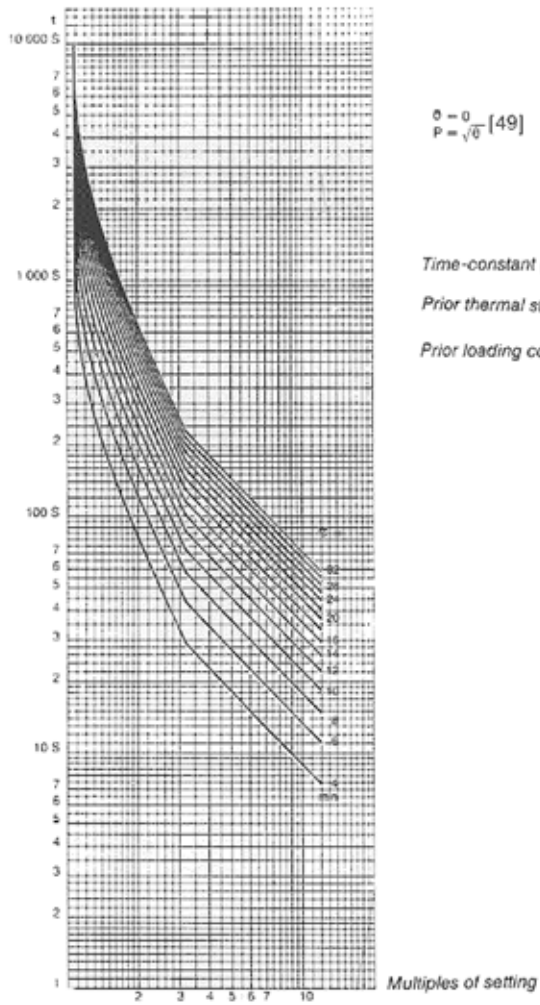
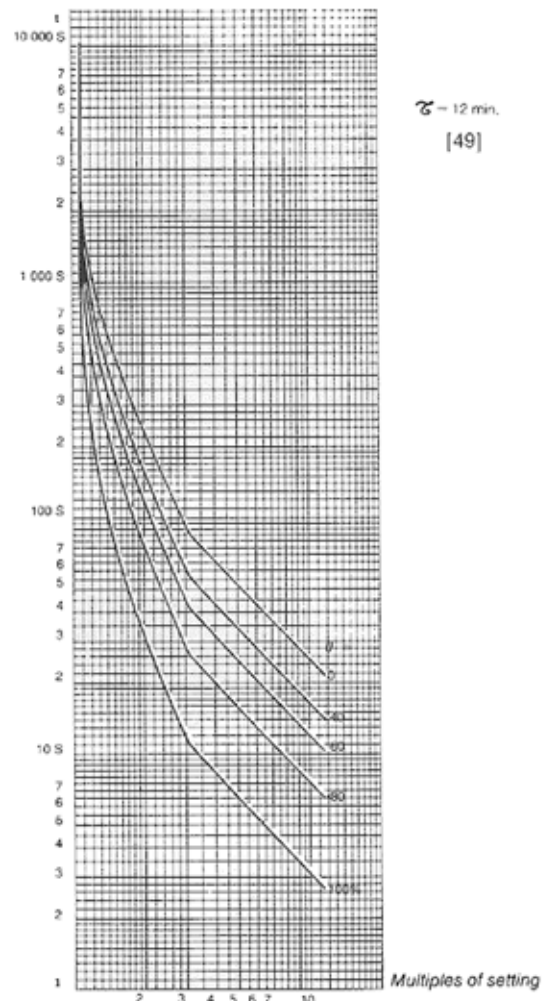


Fig. 3 - IMM 7990: Simplified operation and connection diagram



— Cold characteristics for different time constants.

Fig. 4 - Thermal unit



— 12 min time constant with different prior thermal states.

Fig. 5 - Thermal unit

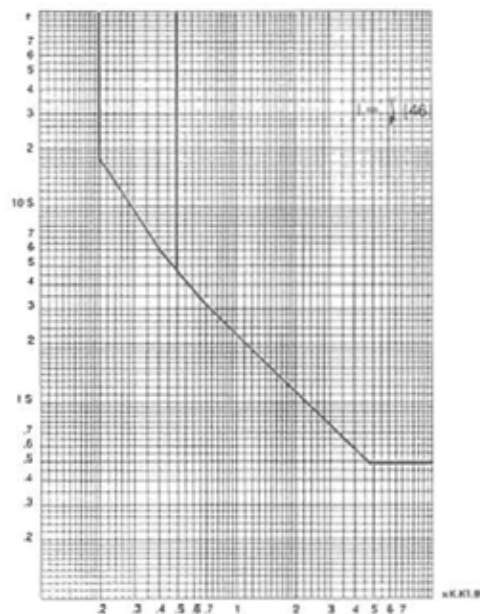


Fig. 6 - Negative sequence unit

CASES TYPE R2 / R3

		<i>projecting front connection</i>	<i>projecting rear connection</i>	<i>flush rear connection</i>
CASE DIMENSIONS	CONNECTING SCREWS Ø M4			
R2	CASE DIMENSIONS			
	DRILLING AND CUT OUT			
R3	CASE DIMENSIONS			
	DRILLING AND CUT OUT			

Only documents supplied with our acknowledgement are to be considered as binding.

The specifications and drawings given are subject to change and are not binding unless confirmed by our specialists.



11, rue Marcel Sembat - 94146 Alfortville cedex - FRANCE
www.groupeice.com - export@icelec.com
 Tel: +33 (0)1 41 79 76 00 - Fax: +33 (0)1 41 79 76 01

