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# Inverse-Time Overcurrent Relays, Types: ICM 2, ICM 21, ICM 22, ICM 23

## Application

The relay type ICM (this designation is used henceforth for simplicity's sake to denote all four variants ICM 2, ICM 21, ICM 22 and ICM 23) is an overcurrent relay with an inverse-time characteristic. That means to say, its tripping time is shorter, the greater the fault current. As secondary relay it is fed by current transformers. It is used to protect parts of electrical installations and simple line systems against short circuits. Except on teed lines the ICM 2 relays can be used together with directional relays for the protection of ring-main systems. For the protection of solidly earthed systems against earth faults there are relays with current settings up to 0.2 A available.
The relay can be employed in all situations where delayed interruption of short circuits is required, provision also being made for instantaneous tripping at a set maximum current.


Fig. 1 – Inverse-time overcurrent relay, type ICM 2h

## Main features

- Reliable, robust Ferraris measuring system without gearing or coupling
- Range of time setting 10–100 % (see current/time characteristic)
- Range of current setting 1 : 4, adjustable in 7 steps by means of non-interrupting setting switch
- High resetting current, at least 96 % of relay setting
- Max. overrun time of 0.02 s
- Temperature-compensated measuring system
- Instantaneous maximum-current trip with own contact and own visual signal
- Instantaneous maximum-current trip, continuously adjustable between $10\,I_n$ (relay setting) and infinity
- Separate double-pole tripping contactor with indicator, for high contact rating
- Low internal consumption
- Plug-in active part, the c.t. connections being automatically short-circuited when the relay is withdrawn
- Tropicalized design

# Design and principle

The relay comprises a temperature-compensated Ferraris measuring system which requires no coupling, gearing or hinged armature. The 1 mm thick Ferraris disc of aluminium is drawn by a recall spring, a recall tape and a worm against a stop on the time adjustment disc, and is thus held in its position of rest. The worm compensates for any change in the force of the recall spring within an angle of rotation of the Ferraris disc of 320°. Thus the recall torque remains constant. The driving torque and with it the angular speed of the Ferraris disc are constant. As a result the current/time characteristics of the relay are exactly proportional. The relays are manufactured with various current/time characteristics, and also for 50 and 60 Hz (Fig. 7). The characteristic determines the type designation of the particular relay. The current coil of the driving solenoid has 14 tappings, corresponding to the seven stages of the non-interrupting setting switch for the relay current.

The adjustment of the time setting disc determines the angle of rotation of the Ferraris disc prior to contact making.

The braking magnet consisting of a pair of cross-magnetized magnets determines the speed of rotation of the Ferraris disc at a given current.

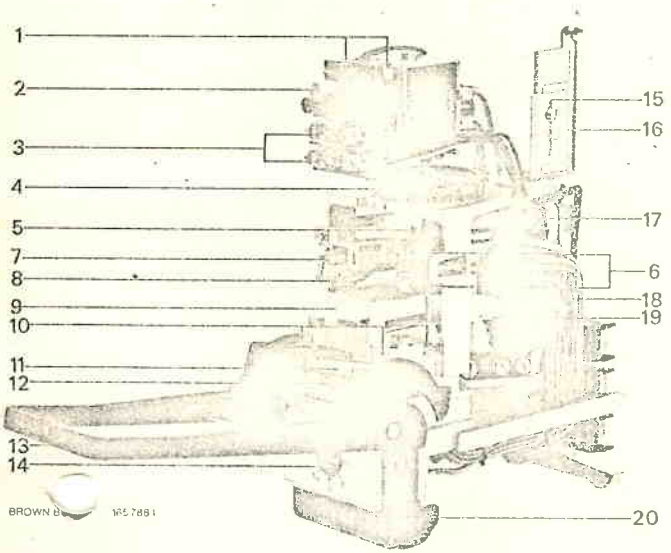


Fig. 2 – Active part of the relay ICM 2 h

1 = Coil terminals of the indicating contactor
2 = Indicator button of delayed trip
3 = Contacts of the indicating release-contactors
4 = Time setting dial
5 = Moving contact pin of the relay time contact
6 = Sprungholder of relay time contact
7 = Indicator button of instantaneous trip
8 = Drum for setting the instantaneous trip
9 = Damping magnet
10 = Scales for adjusting damping
11 = Temperature compensating arm
12 = Pointer of arm 11
13 = Locking arm
14 = Switch for setting relay pick-up current
15 = Slide for adjusting current
16 = Scale for marking factory adjustment of slide
17 = Driving magnet
18 = Coil of the driving magnet
19 = Ferraris disc
20 = Test contacts

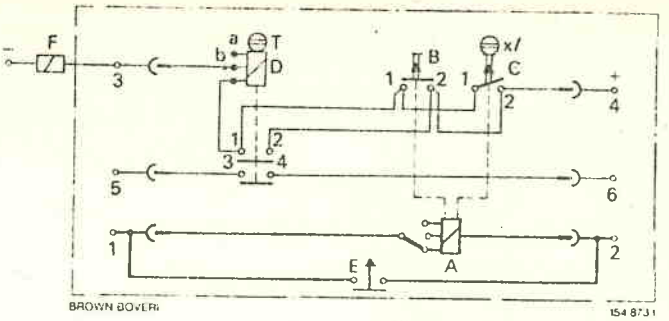


Fig. 3 – Internal circuitry of relays type ICM, indicating contactor with current coil

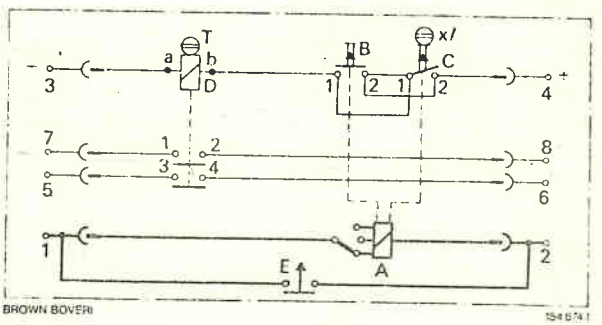


Fig. 4 – Internal circuitry of relays type ICM, indicating contactor with voltage coil

Legend for Fig. 3 and 4:

A = Current coil
B = Time-lag contact
C = Instantaneous contact
D = Indicating tripping contactor
E = Shorting switch
F = Breaker trip coil
T = Signal button of indicating contactor
x/ = Signal button of instantaneous trip

The armature of the instantaneous maximum-current release is drawn by the leakage flux of the driving magnet, acting against the force of a spring. The maximum current setting may be adjusted at the cylinder. When set to infinity (∞) the release is blocked. The release has its own contact (normally open) and a signal button which can be reset from outside.

The indicating release contactor has two separate contacts with double interruption and a signal button which springs out when the relay trips and can be reset by hand.

The coil of the indicating contactor may be a current coil (Fig. 3) energized by the current which trips the breaker. This tripping command is emitted by the main relay and applied direct to the breaker. One of the relay contacts has to be able to make the full tripping current of the breaker. Not until after about 25 ms, when the indicating contactor has picked up, does the latter short-circuit the relay contacts. For this contactor only normally open contacts are permissible, because only then can the internal consumption and thus the resistance of the contactor coils be kept small.

The contactor coil may also be a voltage coil (Fig. 4). When the relay picks up, the contactor coil is connected to the auxiliary voltage by one of the two relay contacts.

The breaker tripping current is handled by the indicating contactor. One of its two contacts may be a normally closed contact.
It is possible to incorporate two separate indicating contactors, one for the inverse-time tripping, the other for the instantaneous maximum-current tripping.
The active part of the relay is plugged into the dust-tight casing. Having reset the signal buttons, the lid can be opened. The locking arm, normally vertical, can then be swung down, in which position the active part of the relay is already disconnected from the leads and the c.t. connections automatically short-circuited. The relay can now be entirely withdrawn from its casing, for instance for testing or repair.

## Test terminals, type suffix 'p'

At the front of the relays are the easily accessible test terminals 20 (Fig. 2). When terminals 11 and 12 are provided for relays with two indicating contactors, test terminals can only be provided for relay terminals 1–10. Circuit 11–12 (signal for instantaneous trip) ist therefore not equipped with test terminals.
For the special model with test terminals a separate test plug (Fig. 5) can be supplied. For testing, it is inserted beneath the pair of lugs in the casing, as shown in Fig. 6, and then the drawout arm is lowered. First of all the shorting switches close, then the connections to the terminals of the casing are interrupted and finally the test terminals are connected to the terminals of the plug.
The test plug is supplied with 3 m of cable but without any terminals on the supply side, as they have to match those of the test set.

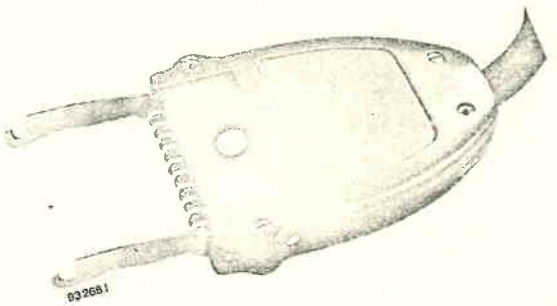


Fig. 5 – Test plug for inverse-time overcurrent relay type ICM 2

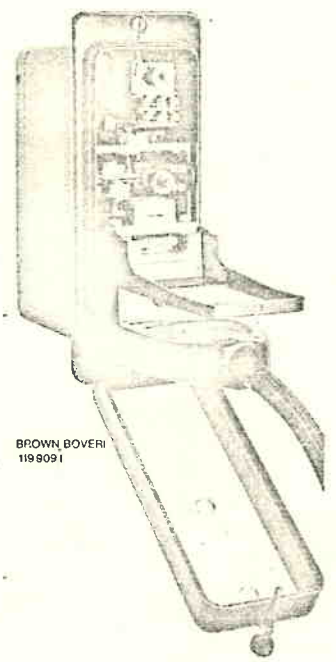


Fig. 6 – Inverse-time overcurrent relay type ICM 2 with test plug inserted, locking arm lowered and relay in the position for testing

# Designation of types

| Type of relay • | | Current/time characteristic 50 Hz | 60 Hz |
|---|---|---|---|
| ICM 2 | Inverse time relay | Fig. 7a | Fig. 7e |
| ICM 21 | Inverse time relay, British Standard | Fig. 7b | Fig. 7b |
| ICM 22 | Very inverse time relay | Fig. 7c | Fig. 7f |
| ICM 23 | Very inverse time relay, special type | Fig. 7d | Fig. 7g |

The relay casing can be supplied for flush mounting in a switchboard. By pushing the mounting frame to the rear of the relay, surface mounting with rear connection is made possible. For surface mounting with front connection an additional adapter frame with a set of terminals is needed (see Figs. page 8).

| Alternative models, suffix to type designation | Suffix • |
|---|---|
| Indicating contactor voltage coil for a.c. | 'a' |
| Indicating contactor current coil for d.c. | 'h' |
| Relay with two indicating contactors | 'k' |
| With pilot lamps for the coils and voltage, parallel to the relay contacts, which light up as long as the tripping circuit is not interrupted by a fault and the relay is in its position of rest | 'm' |
| With instantaneous maximum-current trip | 'n' |
| With starting contact (instead of instantaneous trip) | 'o' |
| With test terminals | 'p' |
| With a means of blocking starting | 's' |

• Please quote when ordering

# Technical data

| Current range: | Relay pick-up current / adjustable to: |
|---|---|
| 4.0/16 A | 4.0 5.0 6.0 8.0 10 12 16 A |
| 2.5/10 A | 2.5 3.0 4.0 5.0 6.0 8.0 10 A |
| 1.5/ 6.0 A | 1.5 2.0 2.5 3.0 4.0 5.0 6.0 A |
| 1.0/. 4.0 A | 1.0 1.25 1.5 2.0 2.5 3.0 4.0 A |
| 0.8/ 3.2 A | 0.8 1.0 1.2 1.6 2.0 2.4 3.2 A |
| 0.5/ 2.0 A | 0.5 0.6 0.8 1.0 1.2 1.5 2.0 A |
| 0.2/ 0.8 A | 0.2 0.25 0.3 0.4 0.5 0.6 0.8 A |

| | |
|---|---|
| Consumption at pick-up current: | |
| 50 Hz | 3.5 3.6 3.7 3.9 4.2 4.4 4.8 VA |
| 60 Hz | 4.1 4.2 4.3 4.6 4.9 5.2 5.6 VA |
| Rated frequency | 50 or 60 Hz |
| Permissible sustained current | 2× set current |
| Short-circuit strength: | |
| thermal (for 1 s) | 100× minimum set current |
| dynamic | 500× minimum set current |

## Timing element

| | |
|---|---|
| Pick-up current /, max. error | ± 4% |
| Time-lag | as per characteristic, Fig. 7 |
| Max. error | up to 2×/: ± 10%<br>2 to 4×/: ± 7%<br>4 to 20×/: ± 5% |
| Reset time when time-lag set to 100% | approx. 9.5 s |
| Max. overrun time | 0.02 s |
| Drop-out ratio | min. 0.96 |
| Contact break time after tripping | max. 0.08 s |

## Instantaneous maximum-current trip

| | |
|---|---|
| Setting range for type ICM 2 and ICM 21 | 2.5–10×/ and ∞ |
| type ICM 22 and ICM 23 | 3 –10×/ and ∞ |
| Max. error | ± 10% |
| Operating at twice set current or over | approx. 0.03 s plus operating time of indicating contactor = 0.03 s |
| Drop-out current | approx. 1.2–2.5× pick-up current / of relay depending on setting |

## Starting contact (instead of instantaneous-current trip)

| | |
|---|---|
| Pick-up value | max. 1.25×/ |
| Drop-out value | min. 0.96×/ |

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Ordering Instructions

1. Type with suffix
2. Current range
3. Rated frequency
4. Auxiliary voltage
5. Diagram No.
6. Art of mounting

## Indicating contactor

| | |
|---|---|
| Indicating contactor with current coil (for d.c. only) | |
| On tapping 0.2 A | coil resistance approx. 10 ohm<br>permissible current 0.2–1.2 A |
| On tapping 1.0 A | coil resistance approx. 0.64 ohm<br>permissible current 1.0–20 A |
| Nature of free contact | normally open (must not be changed to N/C) |
| Indicating contactor with voltage coil | |
| Rated auxiliary voltage | for d.c. 6, 24, 36, 48, 60, 100, 110, 125, 145, 200, 220, 250 V<br>for a.c. 6, 24, 48, 110, 127, 220, 250, 380 V (state frequency) |
| Nominal consumption | on d.c. approx. 2 W<br>on a.c. approx. 5 VA |
| Nature of free contacts | 2 normally open (or 1 N/C and 1 N/O) |
| Operating time | approx. 0.03 s |
| Contact ratings | The contacts of the relay and of the instantaneous trip, when connected as in Fig. 3, are capable of making 30 A at a maximum of 250 V and of carrying this current until they are short-circuited by the normally open contact of the indicating-tripping contactor. They must be interrupted in every case by an auxiliary contact of the circuit-breaker.<br>Indicating contactors with voltage coil (Fig. 4) are actuated without difficulty by both contacts of the relay at voltages up to 250 V. |
| Contactor contacts: | |
| sustained current | max. 10 A |
| making current | max. 30 A |

| Maximal break current | Voltage | 50 Hz a.c. resistive and inductive, p.f. = 0.3 | D.C. resistive | inductive $L/R$ = 15 ms |
|---|---|---|---|---|
| 1 contact | 220 V<br>110 V<br>24–60 V | 20 A | 1.1 A<br>6 A<br>16 A | 0.8 A<br>3 A<br>7.5 A |
| 2 contacts in series | 220 V<br>110 V | –<br>– | 6 A<br>15 A | 3.5 A<br>10 A |

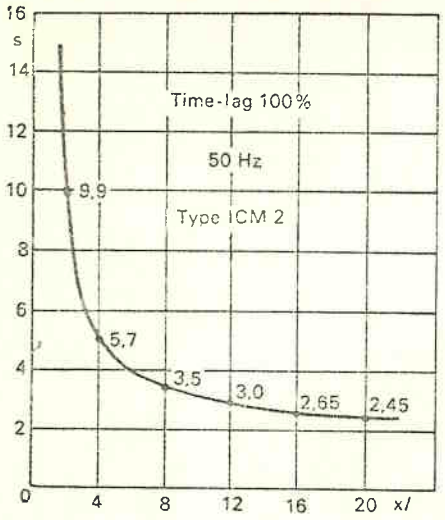
These are max. values for a small number of operations. To attain a contact life of about 10 000 operations, they should be reduced to about 60 %.

## General items

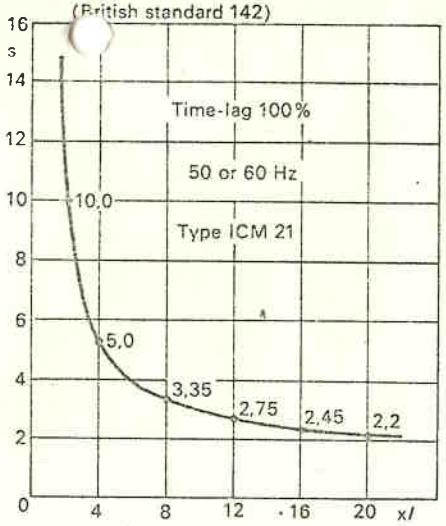
| | |
|---|---|
| Test voltage | 2000 V, 1 min |
| Weight with one indicating contactor<br>Weight with two indicating contactors<br>Weight of test plug with 3 m cable | 3.8 kg<br>4.0 kg<br>1.5 kg |
| Circuit diagrams | see page 2 |
| Dimensions | see page 8 |

• Please quote when ordering

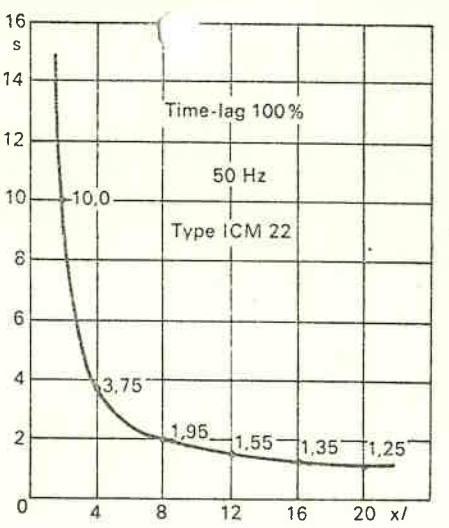
a Inverse time



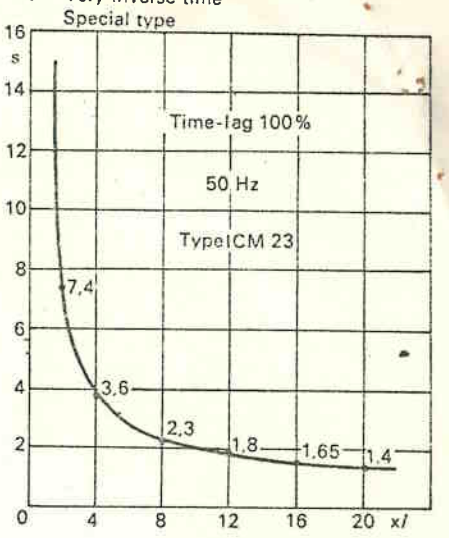

b Inverse time
(British standard 142)



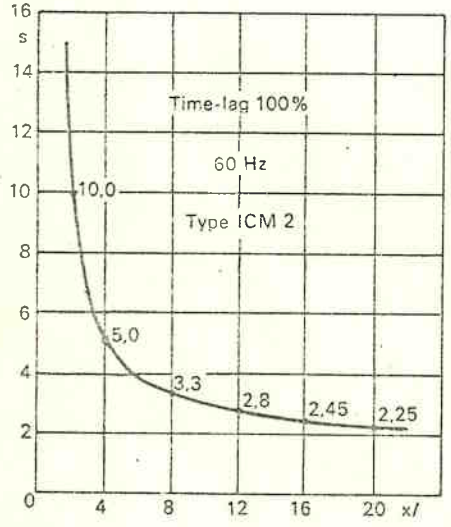

c Very inverse time




d Very inverse time
Special type



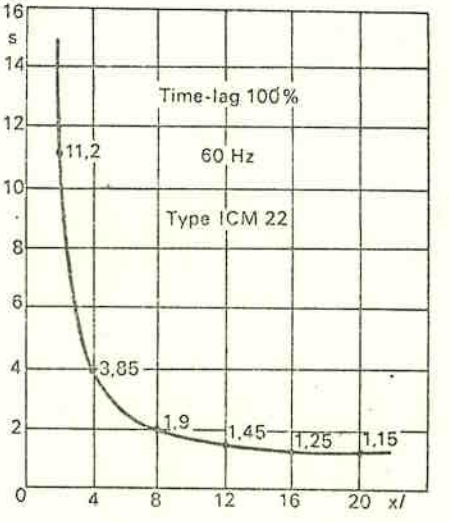

e Inverse time




Note:

When set to less than 100%, the tripping time is correspondingly shorter, e.g. at 50% setting, half the value given by the characteristic.
Range of time setting: 10–100%.

f Very inverse time




g Very inverse time
Special type

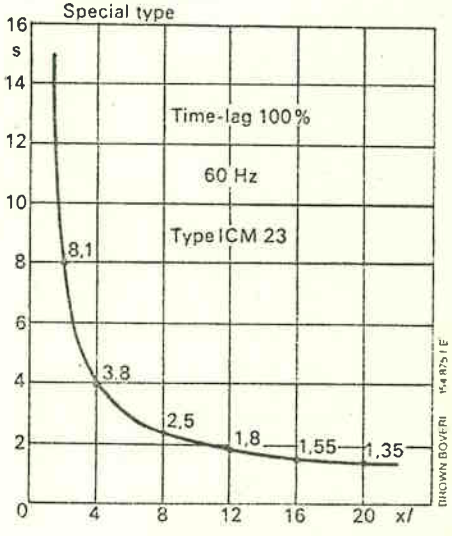





Fig. 7 – Current/time characteristics of inverse-time overcurrent relays type ICM

## Contact arrangements, type designations and circuit diagrams of inverse-time overcurrent relays type ICM 2 for flush or surface mounting, with rear connections

| Relay | | | | Without test terminals | | With test terminals | |
|---|---|---|---|---|---|---|---|
| Type | Design<br>Tripping circuit | Contactor<br>Coil for | Contacts ① | Suffix to type | Diagram No. | Suffix to type | Diagram No. |
| **Relay with 1 contactor having voltage coil** | | | | | | | |
| ICM 2<br>ICM 21<br>ICM 22<br>ICM 23 | Time and maximum current contact both actuate the same contactor | d.c. | 2x | – | AK 421 255 | p | AK 421 256 |
| | | a.c. | | a | | ap | |
| | | d.c. | 1x+1ȳ | – | AK 421 259 | p | AK 421 260 |
| | | a.c. | | a | | ap | |
| | Max. current contact in separate circuit | d.c. | 2x | – | AK 421 267 | p | AK 421 268 |
| | | a.c. | | a | | ap | |
| | | d.c. | 1x+1ȳ | – | AK 421 269 | p | AK 421 270 |
| | | a.c. | | a | | ap | |
| | With pilot lamp. Time and maximum-current contact both actuate the same contactor | d.c. | 2x | m | AK 421 263 | mp | AK 421 264 |
| | | a.c. | | am | | amp | |
| | With starting contact instead of maximum-current contact | d.c. | 2x | o | AK 421 271 | op | AK 421 272 |
| | | a.c. | | ao | | aop | |
| **Relay with 1 contactor having current coil** | | | | | | | |
| ICM 2h<br>ICM 21h<br>ICM 22h<br>ICM 23h | Time and maximum current contact both actuate the same contactor | d.c. | 2x | – | AK 421 251 | p | AK 421 252 |
| | Maximum-current contact in separate circuit | | | | AK 421 265 | | AK 421 266 |
| **Relay with 2 contactors having voltage coils** | | | | | | | |
| ICM 2k<br>ICM 21k<br>ICM 22k<br>ICM 23k | Time and maximum-current contact both actuate the same contactor | d.c. | 2·2x | – | AK 421 275 | p | AK 421 276 |
| | | a.c. | | a | | ap | |
| | | d.c. | 2·(1x+1ȳ) | – | AK 421 277 | p | AK 421 278 |
| | | a.c. | | a | | ap | |
| | With starting contact instead of maximum-current contact | d.c. | 2·2x | o | AK 421 279 | op | AK 421 280 |
| | | a.c. | | ao | | aop | |
| | | d.c. | 2x+(1x+1ȳ) | o | AK 421 281 | op | AK 421 282 |
| | | a.c. | | ao | | aop | |
| | With starting contact instead of maximum-current contact for combination with directional relay | d.c. | 2·2x | o | AK 421 283 | op | AK 421 284 |
| | | a.c. | | ao | | aop | |
| | | d.c. | 2x+(1x+1ȳ) | o | AK 421 285 | op | AK 421 286 |
| | | a.c. | | ao | | aop | |

① x = Make contact ȳ = Break contact

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# Dimensions

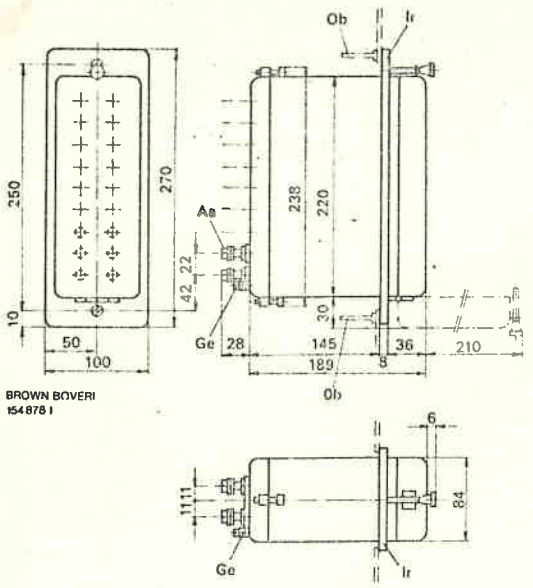


Fig. 8 – Flush mounting, rear connection

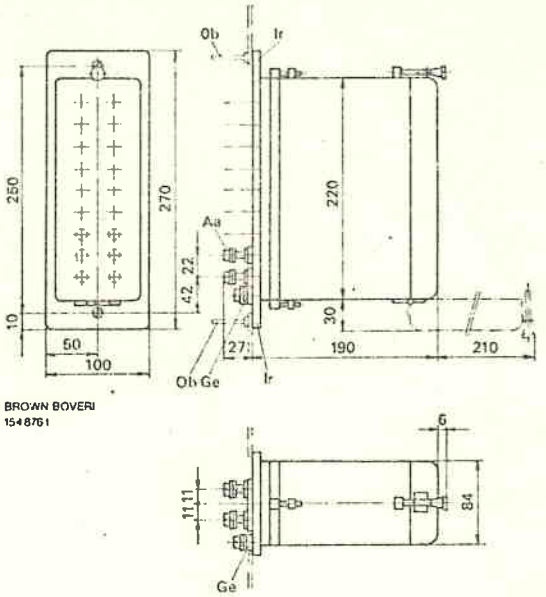


Fig. 9 – Surface mounting, rear connection

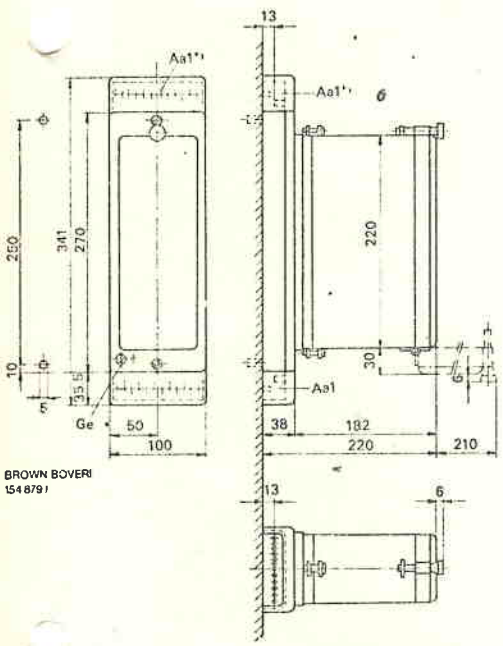


Fig. 10 – Surface mounting, front connection

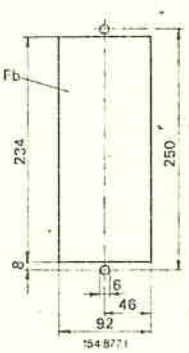


Fig. 11 – Hole in panel for relays in Fig. 8 and 9

Legend

Aa = Rear terminals M 5, number according to circuit diagram, max. 18
Aa1 = Front terminals M 5, number according to circuit diagram, max. 18
Fb = Hole in panel
Ir = Mounting frame, modification for surface mounting possible
Ob = Fixing screw M 5
Ge = Earthing screw M 5
*) = Upper terminal block, only when more than 12 terminals
① = 27 mm for panels up to 17 mm thick
50 mm for panels up to 40 mm thick

Dimensions in millimeters (binding)

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