MINIATURE CIRCUIT BREAKERS

RATING	POLES	MODULES	LIST No Type B	Type C
6A	1	1	**6MSB06**	**6MSC06**
10A	1	1	**6MSB10**	**6MSC10**
16A	1	1	**6MSB16**	**6MSC16**
20A	1	1	**6MSB20**	**6MSC20**
32A	1	1	**6MSB32**	**6MSC32**
40A	1	1	**6MSB40**	**6MSC40**
50A	1	1	**6MSB50**	**6MSC50**

- BS EN 60898; 6kA-240V 50Hz
- Type B classification (3-5 In). Type C classification (5-10In)
- 25mm^2 terminal capacity

RESIDUAL CURRENT CIRCUIT BREAKER WITH OVERCURRENT PROTECTION (RCBOs)

RATING	POLES	MODULES	LIST No 30mA Type B	30mA Type C
6A	1	1	**6FSR06/30B**	**6FSR06/30C**
10A	1	1	**6FSR10/30B**	**6FSR10/30C**
16A	1	1	**6FSR16/30B**	**6FSR16/30C**
20A	1	1	**6FSR20/30B**	**6FSR20/30C**
32A	1	1	**6FSR32/30B**	**6FSR32/30C**
40A	1	1	**6FSR40/30B**	**6FSR40/30C**
50A	1	1	**6FSR50/30B**	**6FSR50/30C**

- BS EN 61009
- 230 (240)V AC 50/60 Hz
- 16mm^2 terminal capacity (outgoing)

SP & SWN RESIDUAL CURRENT CIRCUIT BREAKER WITH OVERCURRENT PROTECTION (RCBOs)

RATING	POLES	MODULES	LIST No 30mA Type C
6A	2	2	**6FSNR063/C**
10A	2	2	**6FSNR103/C**
16A	2	2	**6FSNR163/C**
20A	2	2	**6FSNR203/C**
32A	2	2	**6FSNR323/C**
40A	2	2	**6FSNR403/C**

- BS EN 61009
- 230 (240)V AC 50/60 Hz
- 16mm^2 terminal capacity (outgoing)

ACCESSORIES

Description	LIST No
MCB Padlocking Device	**MCBLD**
Blanking Piece	**443**
Blanking Unit	**CSB1**
Blanking Unit twist fit	**CSBC**

TRIPLE POLE & NEUTRAL 415V 50Hz AC

Description BS EN 60947-3	LIST No
With switched Neutral for surface mounting within a metal enclosure. 133mm x 114mm x 61mm	**1932**
With switched Neutral for flush mounting within a metal enclosure. 150mm x 125mm x 61mm	**1932/F**

DP DOMESTIC SWITCH FUSE

Description	LIST No
DP Domestic Switch Fuse complete with 63A fuse	**191002/63**
DP Domestic Switch Fuse complete with 80A fuse	**191002/80**
DP Domestic Switch Fuse complete with 100A fuse	**191002/100**

The Crabtree Domestic Switch Fuse has a robust steel construction and is complete with a 100A Double Pole Isolator and either 63A, 80A or 100A BS88 Fuse.

Approximate dimensions: Height 305mm, Width178mm, Depth 76mm

For Technical Information see pages 178-181

Crabtree MCBs comply fully with BS EN 60898 and therefore enable the requirements of BS 7671 to be met.

TYPE CLASSIFICATION

BS EN 60898 specifies different tripping characteristics for different types of MCB, depending on the level of overload current required to make the MCB trip out in less than 100 milliseconds. Crabtree MCBs within this publication are available as types B and C, enabling installation designers to choose an MCB with a characteristic closely matched to the circuit requirement.

FAULT LEVELS

Regulation 432.1 of BS 7671 requires that a device providing protection against overload currents and fault currents shall be capable of breaking any overcurrent up to and including the prospective fault current at the point where the device is installed.
In domestic situations this could be as high as 16kA, in industrial situations it could be even higher.
According to regulation 434.5.1, the prospective fault current can be higher than the breaking capacity of the protective device if another protective device having the necessary breaking capacity is installed on the supply side. This means that MCBs can be backed up by devices of greater capacity such as HRC fuses.
When providing back-up protection, consideration must be given to discrimination. Discrimination is said to occur when the device nearest the fault operates first.

AMBIENT TEMPERATURE CONSIDERATIONS

Starbreaker and Loadstar MCBs are calibrated to meet the requirements of BS EN 60898, 30°C Reference Calibration Temperature. At other temperatures the following rating factors should be used:

At 40°C 0.9 At 20°C 1.0 At 0°C 1.1

Adjacent thermal-magnetic MCBs should not be continuously loaded at or approaching their nominal rated currents when mounted in enclosures. It is good engineering practice to apply generous de-rating factors or make provision for adequate free air between devices. In these situations, and in common with other manufacturers, we recommend a 70% diversity factor is applied to the MCB nominal rated current where it is intended to load the MCBs continuously (in excess of 1 hour).

OPERATING CHARACTERISTICS FOR MCBs

MCB type	*BS EN 60898 type*	*Instantaneous trip current range*	*Typical application*
B	*B*	*3–5In*	*Domestic*
C	*C*	*5–10In*	*Commercial Light Industrial*
D	*D*	*10–20In*	*General Industrial*
*1**	*–*	*2.7–4In*	*Domestic*
*2**	*–*	*4–7In*	*Commercial*
*3**	*–*	*7–10In*	*General Industrial*

** MCBs, type 1,2 & 3 to BS 3871*

FAULT PROTECTION

BS 7671, formerly the IEE Wiring Regulations requires that measures are taken to protect against the risk of electric shock, which can be the result of contact with live parts.
MCBs can be used in conjunction with earthed equipotential bonding to achieve disconnection times of 0.4 seconds (411.3.2.2) for final circuits not exceeding 32A and 5 seconds (411.3.2.3) for final circuits exceeding 32A (TN Systems).

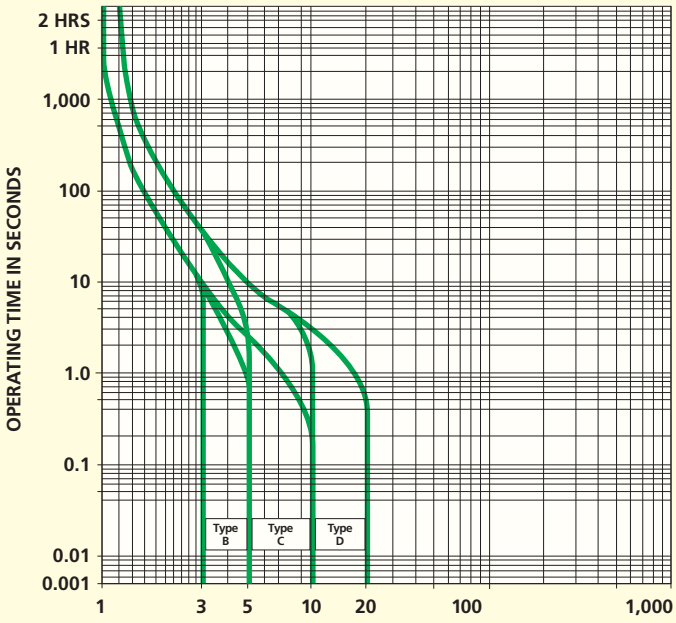
EARTH FAULT LOOP IMPEDANCES (Z_S OHMS) TO GIVE COMPLIANCE WITH BS 7671 REGULATION 411.3.2.2 AND 411.3.2.3 AT 230V

Maximum earth fault loop impedance in ohms for instantaneous operation of devices giving compliance with the 0.4 second disconnection time of Regulation 411.3.2.2 and 5 second disconnection time of Regulation 411.3.2.3.

RATINGS

DEVICE	*BS EN*	*6A*	*10A*	*16A*	*20A*	*32A*	*40A*	*50A*
MCB Type B	*60898*	*7.666*	*4.599*	*2.874*	*2.299*	*1.439*	*1.149*	*0.919*
MCB Type C	*60898*	*3.829*	*2.299*	*1.439*	*1.149*	*0.719*	*0.569*	*0.459*
RCBO 30mA Type B	*61009*	*1667*	*1667*	*1667*	*1667*	*1667*	*1667*	*1667*
RCBO 30m Type C	*61009*	*1667*	*1667*	*1667*	*1667*	*1667*	*1667*	*1667*

- The values in these tables should be modified to allow for the cable temperature at time of test
- RCBO values reflect the rated residual operating current characteristics of the device (table 41.5). For the overcurrent characteristics read as related MCB values.



Technical Specifications Starbreaker & Loadstar Domestic			
Standard			BS EN 60898
Tripping characteristic			B, C
Rated voltages *Un*			230/400
Operational voltage	min. max. max.	V AC/DC V DC/pole V AC	24 60 250
Rated short circuit capacity *Icn*		kA AC	6
Insulation coordination			
• Rated insulation voltage		V AC	250
• Degree of pollution for overvoltage category			2/III
Touch protection acc. to EN50274			Yes
Handle end position, sealable			Yes
Degree of protection acc. to EN60529			IP20
CFC silicone-free			Yes
Terminals			
• Terminal tightening torque		Nm	2.5 ... 3
Conductor cross-section			
• Solid and stranded		mm^2	0.75 ... 25
• Finely stranded, with end sleeve		mm^2	0.75 ... 25
Mounting position			Any
Service life on average, with rated load			20000 actuations
Ambient temperature		˚C	-25 ...+45, occasionally +55, max. 95% humidity, Storage temperature: -40 ... +75

APPLICATIONS

Single pole MCBs with Type B characteristics (3-5In) are suited for use on loads with little or no switching surges, such as occur on domestic applications.
In addition, a Type B MCB will give fault risk protection at higher levels of earth loop impedance. All ratings are also available in Type C classification (5–10In). MCBs with type C characteristics are suited for use where fluorescent lighting circuits, small motors etc. may produce switching surges which would operate a type B circuit breaker.

GENERAL CONSTRUCTION

Starbreaker and Loadstar MCBs are of the thermal-magnetic current limiting type, having a compact construction which has been achieved by not only minimising the number of parts but also the number of welded joints and connections. Critical material selection ensures reliability and durability. The MCB has an easy to operate handle with a trip-free toggle mechanism – so even when the handle is held in the 'on' position the MCB is free to trip.

BACK-UP PROTECTION

Back-up protection is required only if the prospective short circuit current at the point of installation exceeds the breaking capacity of the MCB. When providing back-up protection consideration must be given to discrimination between the MCB and fuse.

DISCRIMINATION

It is desirable that the protective device nearest the fault should operate first. The low energy let through of Starbreaker and Loadstar MCBs provides better discrimination with HRC fuse back-up than is given by earlier types of MCB.

METHOD OF OPERATION

1 Moderate overload conditions

Detection of moderate overload conditions is achieved by the use of a thermo-metal element which deflects in response to the current passing through it. The thermo-metal element moves against the trip bar releasing the trip mechanism.

2 Short circuit conditions

When the current flowing through the MCB reaches a predetermined level, the solenoid directly pulls in the plunger which forcibly separates the contacts and simultaneously releases the trip mechanism.

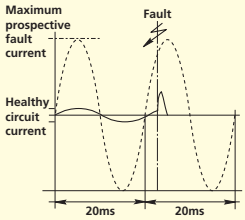
3 Establishment of arc between fixed and moving contacts

As the moving contact moves away from the fixed contact, an arc is established. The arc runs along the arc runner to the arc chamber where it is split up between the plates and extinguished.
The low inertia and consequent high speed of the moving contact has a limiting effect on the flow of fault current. The rapid development of the arc, together with its accelerated extinction in the arc chamber, gives a typical operating time of 3.5–5 milliseconds.

CURRENT LIMITING ACTION

The high speed current limiting action ensures that the MCB operates before the full prospective fault current is allowed to develop.
Under fault conditions, damage can be sustained to the installation and associated equipment due to the amount of energy that passes before the current is completely interrupted. The total energy let-through depends on the value of current and the time for which it flows, and is denoted by the symbol I^2t. The high speed current limiting action of Starbreaker and Loadstar MCBs ensures that the energy let-through and any subsequent damage is minimised. This reduced energy let-through assists greatly with both back-up and discrimination considerations.

CURRENT LIMITING EFFECT



I^2t ENERGY LET-THROUGH

Typical values of I^2t energy let-through for Starbreaker MCBs are given in the table below:

MCB rating (A)	*Total I^2t let-through (A^2 s) Type B*	*Type C*	*MCB rating (A)*	*Total I^2t let-through (A^2 s) Type B*	*Type C*
6	*10,220*	*14,890*	*32*	*31,760*	*32,470*
10	*17,900*	*18,750*	*40*	*31,760*	*32,470*
16	*22,260*	*23,820*	*50*	*45,160*	*44,270*
20	*22,260*	*32,470*			
	Prospective short circuit test current		6000A		

MOUNTING THE MCB

In Crabtree consumer units the MCBs are mounted on standard 35mm top hat rail to BS 5584: 1978 EN 50022 giving a projection within the Standard of 70mm. Due to the method of connection onto the busbar it is not possible to use the Starbreaker range for custom built panels.

MAIN SWITCH

• **Starbreaker**	100/MI2 & 100/2MT
• **Loadstar (Domestic)**	100SW2
• Specification	IEC 60947-3
• Rating	100A 230V 50Hz
• Utilisation category	AC-22A
• Type	Double pole switch disconnector
• Insulation voltage	250V
• Impulse withstand voltage	4kV
• Rated duty	Continuous
• Short-time withstand current	2kA for 1 second
• Short-circuit making capacity	3.5kA (peak)
• Conditional short-circuit current	16kA when protected by 100A HRC fuse to BS 1361
• Pollution degree	3

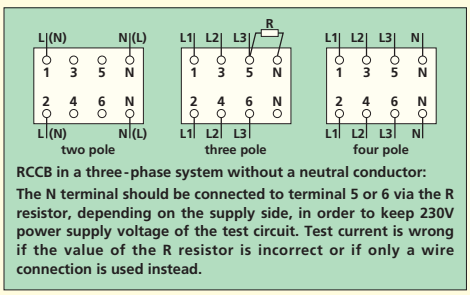
RESIDUAL CURRENT DEVICES (RCCBs, RCBOs and SRCDs)

SPECIFICATION

- BS EN 61008 RCCBs
- EN 61009-1, IEC61009-1 RCBOs
- BS 7288 SRCDs
- Range of current ratings 13–100A
- Range of sensitivities 10–300mA
- Pole configurations SP&N, DP & 4P
  DP SRCD – 230V
- Voltage ratings 1 & 2 Module SP & N – 230V
  2 & 3 Module DP – 230V
  4 Module 4P – 400V
- Frequency rating 50Hz
- Tripping principle employed Electro-mechanical (2, 3 & 4 Module RCCBs)
  Electronic (1 & 2 Module RCBOs)

OPERATION

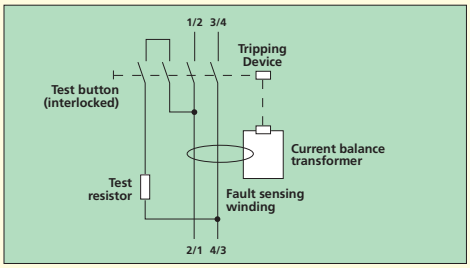
The RCD employs the current balance principle which involves the supply conductors to the load (phase and neutral) being wound onto a common transformer core to form the primary windings. The secondary winding of the current transformer is then connected to the trip mechanism, either an electro-magnetic relay in the case of 2, 3 and 4 module RCCBs or an electronic relay in the case of 1 and 2 module RCBOs. Under healthy circuit conditions, the current in the phase conductor is equal to the current in the neutral and the vector sum of the current is zero. In the event of an earth fault, an amount of current will flow to earth, creating an out of balance situation in the transformer assembly. This out of balance is detected by the secondary winding of the transformer and at a pre-determined level of out of balance will activate the trip mechanism.
Single phase and neutral or three phase and neutral units (suitable for 3 or 4 wire systems) are available, the latter being suitable for balanced or unbalanced 3 phase loads.
The RCD trip mechanism will operate at a residual current of between 50–100% of its rated residual operating current (sensitivity).



RCCB in a three-phase system without a neutral conductor:
The N terminal should be connected to terminal 5 or 6 via the R resistor, depending on the supply side, in order to keep 230V power supply voltage of the test circuit. Test current is wrong if the value of the R resistor is incorrect or if only a wire connection is used instead.

Note
Exposed installation metal work must be earthed.

RCD circuit diagrams (four pole)



Note
Exposed installation metal work must be earthed.

RCD circuit diagram (two pole)

TEST BUTTON

A test button is provided on all RCDs to enable the operation of the device to be checked.
It is recommended that an RCD is tested at least quarterly. (See BS 7671 Regulation 514-12-2).

TERMINAL CAPACITIES

Lifestar RCCBs	50mm²	Lifestar SRCDs	3 x 2.5mm² 3 x 4mm² 2 x 6mm²
Starbreaker RCBOs	16mm²		
Loadstar RCBOs	16mm²		

APPLICATIONS

a) Residual Current Devices (RCDs) may be required to ensure the compliance of an installation with BS 7671, formerly the IEE Wiring Regulations.

An RCD (30mA) meeting the requirements of Regulation 415.1.1 must be used for circuits and cable installations covered by Regulation 411.3.3 (socket outlets), 522.6.6, 522.6.7, 522.6.8 (wiring systems), and 701.411.3.3 (locations containing a bath or shower). Where a high earth fault loop impedance disqualifies the use of overcurrent protection devices as a means of providing the necessary automatic disconnection in the case of a fault, an RCD may be used to satisfy the requirements of Regulation 411.3.2.2 (411.4.9). To comply with Regulation 411.5.3 the earth fault loop impedance in Ohms multiplied by the rated tripping current of the RCD in Amperes must not exceed 50(V). With the RCD having a sensitivity of 30mA, the maximum permissible earth fault loop impedance is calculated as follows:
Z_S (max)=50/0.03=1666 Ohms

Rated residual operating current (mA)	*Maximum earth fault loop Impedance* Z_S Ohms *120V<Uo≤230*
30mA	*1667*
100mA	*500*
300mA	*167*

(b) to provide a higher level of protection than that given by direct earthing, against fire or shock risks caused by earth leakage currents.

Overcurrent protection devices cannot detect earth fault currents below their operating current. If they are the only means of earth fault protection, it is possible for sufficient earth fault current to flow undetected to constitute a fire risk.
By using an RCD, the flow of the sustained earth fault current, above the tripping current of the RCD, is prevented. The shock risk associated with these earth fault currents is also greatly reduced.
To provide complete personnel protection, a high sensitivity RCD to a Type A classification with a maximum tripping current of 30mA should be used. This is particularly important with portable appliances where there is a danger of losing earth continuity due to damage or fatigue.
Residual current devices are completely selective in their operation. They are unaffected by parallel earth paths and are thus ideally suitable for the protection of installations in modern high density dwellings or office blocks. They are virtually tamperproof and provide a predetermined level of protection. Even if earthing conditions deteriorate substantially, they will continue to provide a higher level of protection than would have been given by direct earthing.

SENSITIVITIES

10mA provides the highest degree of personal protection, for use in sensitive areas such as laboratories, schools and workshops where potential hazards exist from electrical faults caused through misuse, accidental damage or failure of electrical appliances.

30mA provides a high degree of personal protection, satisfying the requirement of Regulation 415-1 for additional protection. (when an operating time not exceeding 40ms at 5 times rated residual operating current is proven.

100mA provides a high level of fire risk protection and a degree of fault protection.

300mA provide fire risk protection.

TRANSIENT EARTH LEAKAGE CURRENTS

All Crabtree residual current devices incorporate a high level of immunity to tripping when subjected to transient earth leakage currents.
Such transients can occur when there is a significant level of capacitance to earth as can result from cable capacitance (particularly MICC) or RF filter networks. Crabtree RCDs are therefore less susceptible to nuisance tripping due to transient earth leakage currents.

Technical Specifications (RCBOs)			up to 50A
Standards			EN 61009-1, IEC 61009-1
Approved acc.to			IEC/EN 61543
Rated voltages *Un*		V AC	230(240)
Rated frequency *fn*		Hz	50 ... 60
Rated currents *In*		A	6, 10, 16, 20, 32, 40, 50
Rated residual currents $I_{\Delta}n$		mA	30
Rated switching capacity		kA	6
Energy limitation class			3
Terminals/conductor cross-sections			
• Solid and stranded		mm^2	0.75 ... 35
• Finely stranded, with end sleeve		mm^2	0.75 ... 25
Outgoing		mm^2	0.75 ... 16
Terminal tightening torque		Nm	2
Mains connection			Bottom
Mounting position			Any
Degree of protection	acc. to EN60529		IP20 with connected conductors
Touch protection	acc. to EN50274		Finger and back-of-hand safe
Service life	Test cycle acc. to IEC/EN 61009	switching cycles	,10000 actuations
Storage temperature		°C	-40 ...+45
Ambient temperature		°C	-25 ...+45
Resistance to climate acc. to IEC60068-2-30			28 cycles (55°C; 95% rel. air humidity
CFC and silicone free			Yes

APPLICATIONS

RCBOs provide both earth fault and over current protection. The MCB element of Starbreaker and Loadstar devices are available as Type B or Type C making them suitable for domestic or light commercial applications. These Type A Voltage dependent devices are single pole with solid neutral one module wide (18mm) with a flying lead. During interruption of the neutral conductor the protective function is guaranteed when FE and PE conductors are connected. The use of Starbreaker and Loadstar 30mA RCBOs provides independent RCD protection to individual circuits offering both the degree of additional protection that may be required by Regulation 415.1 and the minimum of inconvenience following a single earth fault (Regulation 314.1).

INSTALLATION TESTING – **CAUTION**

As Starbreaker and Loadstar RCBOs employ electronic components they should be disconnected when carrying out the following tests on the electrical installation:

(a) Earth fault loop impedance test

The load terminals should be disconnected if it is intended to parallel-out the unit for test purposes.

It may incur damage if mains potential is maintained on the load terminals of this unit after the trip mechanism has operated.

(b) Insulation test

Whilst RCBOs can withstand the effects of normal insulation testers without damage, false readings may be given on the test instrument. For this reason it is recommended that the device is disconnected during this test.

FAULT CURRENT SENSITIVITY

Semi-conductor devices are now incorporated in equipment used throughout industry, commerce and in the home. Typically, the purpose of these semi-conductor devices is for monitoring and controlling industrial equipment eg speed controls for small motors and temperature controls, along with extensive use in computers, VDUs, printers, washing machines, etc.

As the equipment is fed from the mains electrical supply, in the event of an earth fault the presence of semi-conductors may result in the normal ac waveform being replaced by a non-sinusoidal fault current. In some cases the waveform may be rectified or chopped. These waveforms are said to contain a pulsating dc component which can either partially desensitise or totally disable a standard Type AC RCD.

International standards IEC 61008 (RCCBs) and IEC 61009 (RCBOs) divide RCDs into two performance classes:

Type AC

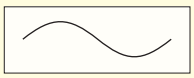
RCDs for which tripping is ensured for residual sinusoidal alternating currents, whether suddenly applied or slowly arising.

Type A

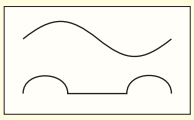
RCDs for which tripping is ensured for residual sinusoidal alternating currents and residual pulsating direct currents, whether suddenly applied or slowly arising.

To ensure the correct level of protection, check for the following symbols:

TYPE AC
normal
ac sensitivity



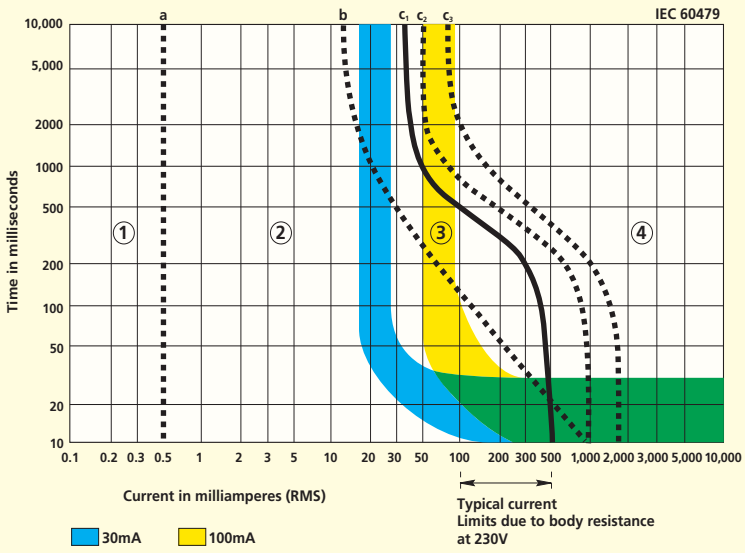
TYPE A
pulsating
dc sensitivity



Crabtree RCCBs are available as both Type AC and Type A devices.

IEC PUBLICATION (60479) CURVES WITH CRABTREE RCD CHARACTERISTICS SUPERIMPOSED

TIME/CURRENT ZONES OF EFFECTS OF AC CURRENT (15–100Hz) ON PERSONS



Zone	Physiological effects
1	Usually no reaction effects.
2	Usually no harmful physiological effects.
3	Usually no organic damage to be expected. Likelihood of muscular contraction and difficulty of breathing, reversible disturbances of formation and conduction of impulses in the heart, and transient cardiac arrest without ventricular fibrillation increases with current magnitude and time.
4	In addition to the effects of zone 3, probability of ventricular fibrillation increased up to 5% (Curve C2) up to 50% (Curve C3) and above 50% beyond Curve C3. Increasing with magnitude and time, pathyphysiological effects such as cardiac arrest, breathing arrest and heavy burns may occur.