Portable Earthing

ENERGY IS OUR BUSINESS

SICAME AUSTRALIA

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Portable Earthing Devices

General

Portable Earthing Devices (portable earths) are personal protective devices which are used to protect electrical workers if the high voltage equipment they are working on is re-energised. In the even that a conductor is energised inadvertently, the aim of a portable earth is to:

- Provide a controlled path for the short circuit current away from an exposed worker to allow short circuit detection equipment to operate and disconnect supply quickly, and
- To minimise the voltage rise and reduce the chance of electric shock occurring.

In Australia and New Zealand, portable earths must be used when working on high voltage (>1000V) networks. They are not generally required for work on low voltage networks.

Legislative Requirements

In Australia and New Zealand, electrical safety laws apply to a broad range of electrical work and apparatus. These laws encompass a number of concepts in legislation to ensure the safety of people and plant when working on electrical apparatus.

Four concepts that are related to the use of portable earths are:

- It is illegal to perform work on high voltage electrical equipment without a system of earthing in place unless live working procedures are being used
- Safety clearance exclusion zones apply to energised and de-energised electrical apparatus at all time unless it has been disconnected from supply, tested, and earthed
- Employers are obliged to provide safe systems of work including portable earths for employees to ensure their electrical safety when working on high voltage networks, and
- Employees who are required to use portable earths must use them when required and ensure that they are used and fitted properly, and are adequate for the job.

Harsh penalties apply for breaches of legislation.

IEC Standards for Portable Earths

Within Australia, there is no particular national standard that applies to the development and use of the portable earthing systems. However, the International Electrotechnical Commission (IEC) provides a suitable standard that can be adopted to provide safe and reliable portable earthing systems. The IEC is a world-wide organisation for standardisation and seeks to promote international co-operation on issues concerning electrical and electronic fields.

IEC Standard 61230

IEC Standard 61230 applies to portable equipment for earthing and short circuiting. This document sets standards for the design of complete portable earth systems which includes clamps, cables, type tests of one or more items representative of the production, short circuit tests, sampling tests and routine tests. The use of an IEC standard which is adopted and exercised daily around the world for earth systems provides confidence for workers and business that these systems will protect personnel in the event that the work area is inadvertently energised.

Portable Earthing Devices

Legislative Requirements

Type testing is a process which is recognised as the best means to ensure that a design will do the job. Sicame Australia has the benefit of over 20 years of designing and supplying portable earth systems to industry around Australia that meet or exceed IEC 61230. A key feature of these systems is that the components of each type of earth system design have been type tested according to the requirements of IEC61230.

One of the most important features of any earthing system is its thermal mechanical abilities to withstand the heat and dynamic mechanical forces that are created during a fault without being destroyed. Type testing to simulate these conditions is critical to ensure that any given design will not fail under conditions that simulate its design rating.

Voltage Ratings

Portable earths are not designed for any particular voltage. However, legislation required that safety clearance exclusion zones must apply during the earthing process. Therefore, the length of any operating stick which is used to apply a portable earth must be longer than the minimum safe distance to the apparatus as defined by the normal energised voltage and the safety exclusion zones where it will be used.

Current and Time Ratings

Portable earths are designed, manufactured and rated to a maximum energy which is determined by a specific current measured in amps for a specific time measured in seconds. For example, a typical rating is 25,000 amps for 0.5 seconds. During a short-circuit fault current, a portable earth must be ale to withstand a maximum amount of electrical energy without failing. There are two mechanisms working together by which a portable earth may fail. These are:

- Thermal mechanism - High temperature rise of the conductor and sheath caused by the current which will soften and melt the cable strands and the sheath, and
- Magnetic mechanism - Enormous mechanical forces caused by the magnetic field of the current which will tend to tear the cables apart and also tear them from lugs, and may even break lugs and clamps.

These two mechanisms combine to destroy a portable earth set as a result of high temperatures that soften the cable conductor strands which reduce its ability to withstand the mechanical forces that attempt to pull it apart.

It is therefore critical that any portable earth is rated to a higher short circuit current than the prospective short-circuit and earth fault levels that are possible on the network in which it will be used. Within Australia and New Zealand, most supply utilities operate high voltage networks that use short circuit protection systems which will detect and disconnect a short circuit current between about 0.3 seconds and 1 second. For this reason, typical ratings of portable earths are specified for a standard time of either 0.5 seconds or 1 second.

Generally, Sicame Australia carries out type tests of its designs to 0.5 seconds in favour of 1 second ratings. The reason for this is that a 0.5 second type test requires a test current that is 1.414 (=√2) times higher than the test current for a 1 second rating of the same energy rating. Consequently, this increases the dynamic mechanical forces by a factor of 1.414 compared to a 1 second fault rating.

For this reason, although it seems counter-intuitive, type tests which meet a 0.5 second rating are much tougher to pass than a 1 second rating. A portable earth is made from a number of components such as cable, lugs, clamps, and other connectors which usually have different fault ratings. The overall fault rating of a complete portable earth is determined by the component with the lowest fault rating used in it. Clamps which are used in any given portable earth are generally rated higher than the cable and lug combination. There is a wide range of short circuit fault levels in supply networks, and users consider the configuration and resulting weight of any portable earth they need. Portable earths must be carried to the work site and fitted to apparatus which, due to normal construction practices for overhead electricity supply networks, is usually at height. The overall weight and frequency of use of any portable earth is then a very important factor in the choice of configuration and use of components.

To meet these requirements, Sicame Australia has standardised its range of portable earths around three different aluminium cable sizes to deliver four different ratings as determined by the cable used in a portable earth. The fourth rating of 45kA for 0.5 seconds is achieved by connecting two cables in parallel so that each cable carries half of the fault current in the event that it is energised.

1. 10,000 Amps for 0.5 seconds, (10kA/0.5secs)
2. 16,000 Amps for 0.5 seconds, (16kA/0.5secs)
3. 25,000 Amps for 0.5 seconds, (25kA/0.5secs)
4. 45,000 Amps for 0.5 seconds, (45kA/0.5secs)

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PORTABLE EARTHING

Portable Earthing Devices

Conversion of Current and Time Ratings

Note that current ratings for 0.5 seconds can be converted to a thermal (heat rise) equivalent 1 second rating by dividing the current rating for 0.5 seconds by 1.414. For example, a rating of 10kA for 0.5 seconds is thermally equivalent to 7.1kA (=10kA/1.414) for 1 second. This is a thermal equivalent rating only and not a mechanical force equivalent rating because although a test current of 10kA for 0.5 seconds will transfer the same amount of electrical energy in that time, the mechanical forces produces by 10kA will be greater than those produced by a lower current of 7kA by a factor of 1.414.

Aluminium Cables

For the benefit of the worker who must lift and attach portable earths, Sicame Australia uses multi-stranded aluminium cables in a wide range of lightweight earth sets designed to reduce the risk of back and other strain injuries. These cables are covered in a distinctive yellow PVC sheath for thigh visibility.

If required by a customer, portable earths that have been type tested and rated to a 0.5 second rating (say, 10kA for 0.5 seconds) can be labelled with a 1 second rating because for type testing purposes, the test current required for 1 second is lower than a 0.5 second rating. However, as explained above, a 1 second rating cannot be converted to a 0.5 second rating because the test current required for 1 second would be lower than that required for a 0.5 second rating.

Earth set configurations for almost any type of installation, including overhead and underground networks, and substations can be designed. They have been tested to 0.5 second ratings to meet IEC-61230.

Details of aluminium cables made by Olex in Australia are in table 1 below.

Rating for 0.5 second	Conductor Area (mm sq)	No. of Strands/ Strand Diameter (mm)	PVC V75 Sheath	OD (mm)	ID (mm)	Wt (kg/m)
10kA	55	570	Yellow, Black Stripe	12.9	10.7	0.22
16kA	85	874	Yellow, Orange Stripe	15.4	13.3	0.32
25kA	130	1332	Yellow	18.5	16.4	0.47
45kA	2 x 130	2 x 666/0.5	2 x Yellow	18.5	16.4	0.97

Copper Cables

Copper cables made by CATU in France can also be supplied in those cases where customers specifically require portable earths that are made using copper cables. These cables have been tested by CATU to 1 second ratings.

They are available in two types of sheath, either transparent PVC, or transparent silicon. The transparent silicon sheath cables have been tested to 1 second ratings under IEC-61230.

Details of copper cables with silicon sheaths to IEC-61230 made by Catu are in the table 2 below.

Rating for 1 second	Conductor Area (mm sq)	Silicon Sheath	OD (mm)	Wt (kg/m)
3.5kA	16	Transparent	5.6	0.156
6kA	25	Transparent	7.5	0.275
8kA	35	Transparent	9	0.386
12kA	50	Transparent	10	0.545
16kA	70	Transparent	12	0.768
20kA	95	Transparent	14	0.800
30kA	120	Transparent	17	1.280
40kA	150	Transparent	19	1.630

PORTABLE EARTHING

Portable Earthing Devices

CATU Electrical Safety Equipment

CATU is a European manufacturer of high quality electrical safety equipment based in France. CATU tools and equipment are used by power utilities, electrical contractors, large industries and railways in about 100 countries spread over five continents.

CATU Clamps

CATU manufacture a wide range of clamps for short circuiting and earthing situations for both indoors and outdoors. Variations include:

- Fault rating
- Jaw opening distances
- Clamping mechanism
- Application methods and tightening of jaws
- Fittings that attach clamps to a temporary operating stick or rod.

The clamps are generally designed and type tested to IEC 61230. CATU performs type testing of its clamp range to meet 1 second ratings. Furthermore, Sicame Australia has also conducted type tests of these clamps over time, but usually under more onerous conditions to meet 0.5 second ratings. This requires a higher test current than 1 second rating tests, so it creates higher mechanical forces during the first few cycles of a short circuit.

CATU Clamps

The CATU range of earthing clamps are available in three distinct connection types. The hexagon, shotgun and bayonet fitting. When ordering our range of CATU clamps, please refer to the table below for appropriate connection type.

CATU Snap-On Clamps

These are a 'Snap-on' spring-loaded clamp which is particularly easy to use and very quick to place on a conductor compared to traditional screw type of clamps. The produce code for these clamps is MT-613/3.

The CATU 'Snap-on' clamps shown at right offer the quickest and easiest way to apply phase clamps to a conductor.

To apply these clamps, the operator sets the spring-loaded jaw on each clamp, and then mounts the clamps onto an application plate on the end of a removable operating stick. The clamps can then be lifted over the conductor and 'snapped' onto it.

To remove the clamps, a clamp removal tool is used to pull each clamp from the conductor. Refer to product code series, CRA for the clamp remover, also know as a 'pigtail'.

Ordering Suffix	Part Number Example	Description
C	MT-815-C	Hexagon Fitting
S	MT0815-S	Shotgun Fitting
E	MT-815-E	Bayonet Fitting

MT-815-C
Hexagon Fitting

MT-815-S
Shotgun Fitting

MT-815-E
Bayonet Fitting

Clamps

Spring loaded Clamps

MT-613/3

Snap on phase clamp rated to 25KA for 0.5 seconds. Suitable for attachment to circular cable ranging from 3mm - 33mm.

MT-612

Phase clamp rated to 10KA for 0.5 seconds. Suitable for attachment to circular cable ranging from 10mm - 30mm.

MT-701

Phase clamp rated to 45KA for 0.5 seconds. Suitable for attachment to circular cable ranging from 12mm - 48mm.

Screw up Clamps

MT-815

Phase clamp rated to 45KA for 0.5 seconds. Suitable for attachment to circular cable and flat bar ranging from 5mm - 40mm.

Clamp	Rating 0.5 sec	Dimensions (mm)	Diameter (mm)	Weight (grams)	End fitting
MT-815-C	45KA	44 x 100 x 180	5 - 42	600	Hex
MT-815-E	45KA	44 x 100 x 180	5 - 42	600	Bayonet
MT-815-S	45KA	44 x 100 x 180	5 - 42	600	Shot-gun
MT-815-EV	45KA	44 x 100 x 180	5 - 42	600	Taplin
MT-815-EH	45KA	44 x 100 x 180	5 - 42	700	Handle 300mm

MT-1921

Phase clamp rated to 45KA for 0.5 seconds. Suitable for attachment to circular cable and fixed ball ranging from 5mm - 40mm.

Clamp	Rating 0.5 sec	Rating 1 sec	Weight (grams)	End Fitting
MT-1911-E	20KA	20KA	580	Bayonet
MT-1911-EH	20KA	20KA	680	Handle 300mm
MT-1912-E	45KA	30KA	600	Bayonet
MT-1912-EH	45KA	30KA	700	Handle 300mm

PORTABLE EARTHING

Clamps

Screw up Clamps cont.

MT-736-085

Phase clamp rated to 45KA for 0.5 seconds. Suitable for attachment to circular cable ranging from 16mm - 85mm.

Clamp	Rating 0.5 sec	Weight (kg)	End Fitting
MT-736-085-E	40KA	1.25	Hex
MT-736-150-E	40KA	1.75	Hex
MT-736-220-E	40KA	2.35	Hex

MT-840/1

Phase clamp rated to 16KA for 0.5 seconds. Suitable for attachment to circular cable and flat bar ranging from 0mm - 25mm.

MT-843

Phase clamp rated to 30KA for 0.5 seconds. Suitable for attachment to circular cable and flat bar ranging from 0mm - 35mm.

MT-847

Phase clamp rated to 25KA for 0.5 seconds. Suitable for attachment to flat bar ranging from 0mm - 13mm.

MT-870

Lockable phase clamp rated to 25KA for 0.5 seconds. Suitable for attachment to circular cable and flat bar ranging from 0mm - 25mm.

Portable Earthing Configurations

Portable Earth Configurations -

Portable earth configurations vary by the was that connections are made of the phase leads and earth leads. The connection configuration of any earth set is determined by its application and the particular operating practices and experience of the user. Sicame Australia generally manufactures earth sets to the requirements of the user, and also has a standard range of earth sets from which to choose that use aluminium cable made by Olex in Australia, and clamps made by CATU in France.

The major types of connection configuration are summarised below.

Three Phase Shorting Circuit sets and separate earth lead

Three phase shorting sets without an attached earth lead are generally used for shorting the 3 phases of a rural overhead distribution network. A separate earth lead is then used to connect the shorted phases to the earthing system.

The separation of the earth lead helps to eliminate extra lifting weight, particularly in rural areas, where conductors may be higher than usual, resulting in very long earth leads. These configurations offer the lightest design for lifting onto overhead conductors as they eliminate one extra phase lead and a trifurcating plate.

For rural situations where there may be significant amounts of single wire earth return networks (SWER), phase shorting sets with a separate earth lead may be more convenient because only the single phase earth set in the kit will need to be applied.

A convenient clamp parking bar for screw type clamps can be fitted to the centre phase clamp for storage of the outer phase clamps until the centre phase clamp has been placed on the conductor.

Looped Shorting and Earth sets

These are three phase shorting sets with an attached earth lead and are generally used for urban distribution networks where there are no SWER networks.

Three Phase Trifurcating Plate Sets

Three phase trifurcating plate sets are generally used in substations and switchboards where there is a single earth attachment point for connection of all three phases together. The tri-plate is fitted with an insulating cover rated to 600V where a separate earth lead is connected.

PORTABLE EARTHING

Portable Earthing Configurations

Fixed Stick Earth Sets

Permanently fixed sticks can be fitted to different types of phase clamps. Generally, the fixed sticks are made from fibreglass insulated rods which are 1800mm long and 32mm in diameter. If required, customers can specify the stick length they need when they request a quote.

Single Phase Earth Sets

Single phase earth sets are commonly found where it is more practical to connect each phase to a separate earth point. Examples are SWER networks, or MV (medium voltage) and EHV (extra high voltage) transmission line and substation situations where there is considerable distance between phases on large towers and other structures.

Transmission networks often emply 3 single phase earths due to the long distances between phases and earth points on large steel structures. For these applications in particular, CATU make an earth clamp which has been specifically designed for clamping onto steel structures.

The clamp, know as an MT-847, has a moving jaw which has been designed to cut through pollutants and high resistance surfaces on steel work.

Equipotential Bonds (EQB's)

Equipotential bonds are a limited type of portable earth which are intended to connect only non-energised metallic parts within a work zone to a common earth point. The purpose is to limit the potential voltage rise in the event of a short circuit occurring in the vicinity of the worksite.

They are usually a single phase lead with an earth clamp on one end, and either another earth clamp, or phase clamp at the other.

These should be rated to the same rating as any portable earth which are used at the same work site.

These are commonly used as earth bonds on vehicles that are required to work around exposed live parts such as trucks and cranes.

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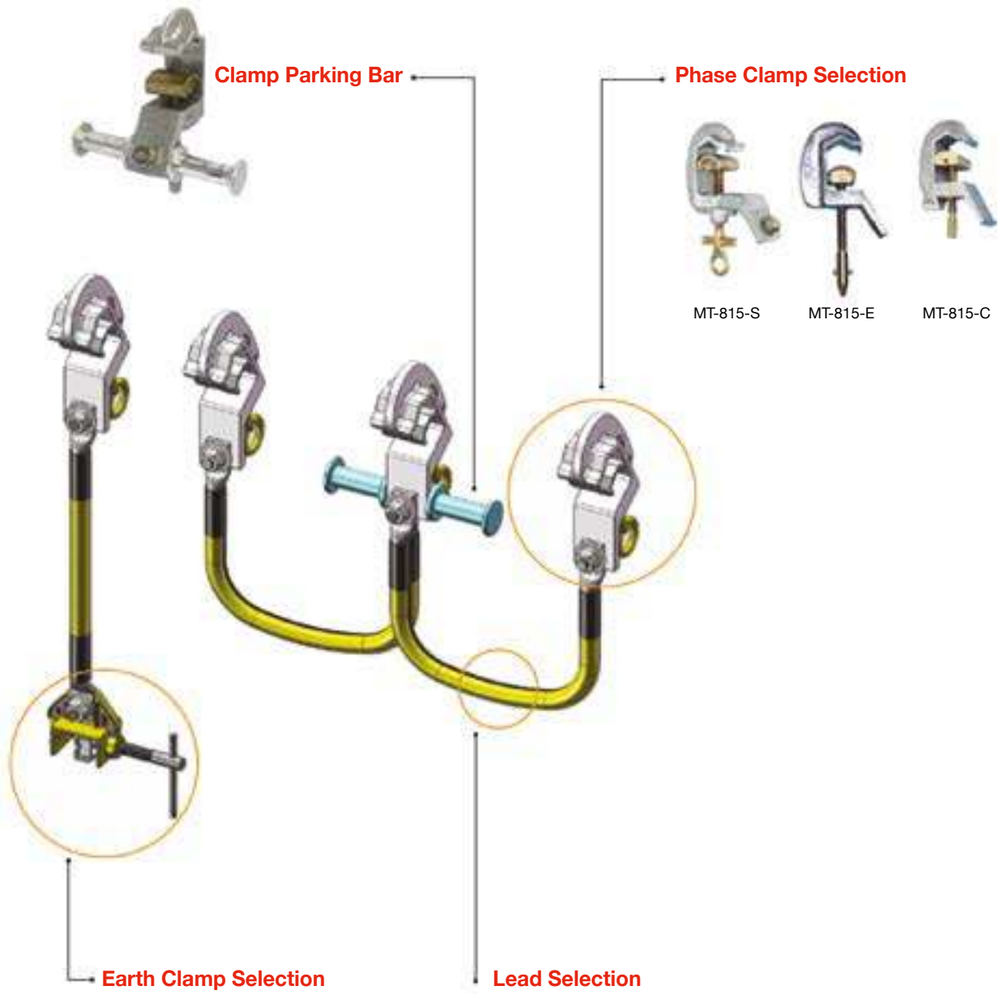
Portable Earthing Configurations

■ Earth Sets - Screw Clamps

Three Phase Shorting Set with Separate Earth Lead

Typical use:

- **OH conductors, including SWER systems**
- Convenient parking bar for outer phases.



MT-815-S MT-815-E MT-815-C

MT-840/1 MT-843

Rating 0.5 Seconds	10kA	16kA	25kA	45kA
Aluminium Stranded Conductor Size	55mm²	85mm²	130mm²	2 x 130mm² in parallel
Lead Lengths (m)	1 to 20	1 to 20	1 to 30	1 to 20
PVC Sheath Colours	Yellow with black stripe	Yellow with orange stripe	Yellow no stripe	Yellow no stripe

Portable Earthing Configurations

■ Snap-On Earths

Three Phase Shorting Set with Looped Earth Lead

Typical use:

- **OH conductor networks.**

MT-815-E
Snap on clamp

MT-840/1 MT-843

Rating 0.5 Seconds	10kA	16kA	25kA	45kA
Aluminium Stranded Conductor Size	55mm²	85mm²	130mm²	2 x 130mm² in parallel
Lead Lengths (m)	1 to 20	1 to 20	1 to 30	1 to 20
PVC Sheath Colours	Yellow with black stripe	Yellow with orange stripe	Yellow no stripe	Yellow no stripe

Hot Stick Accessories to Suit

- **MT-630 # Application Platform**
- **CRA- # Removal tool**

Where # is "C" for CATU hexagonal quick fit system, or "K" for universal sunrise fitting.

MT-630-C
Application Platform

CRA-C
Clamp Remover

MT-630-K
Application Platform

CRA-K
Clamp Remover

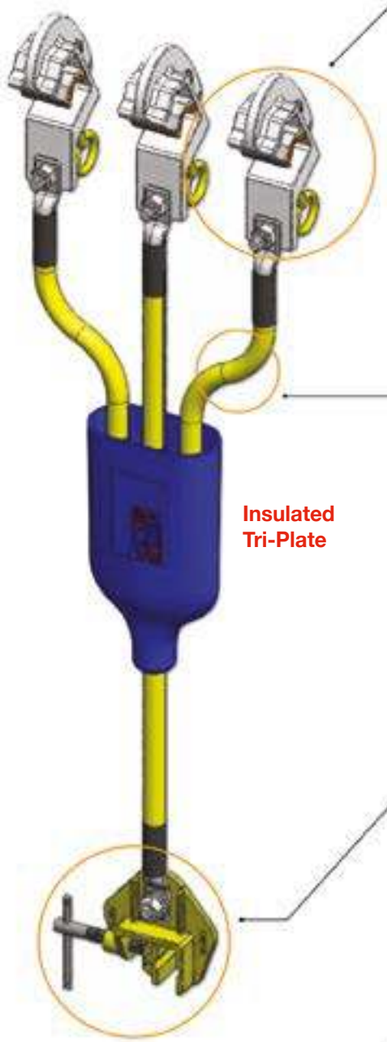
Portable Earthing Configurations

■ Substation & Switchboard Earths

Three Phase Shorting Set with Tri-plate Earth Lead

Typical use:

- **For earthing of indoor and outdoor substation bus bars.**



Insulated Tri-Plate

Phase Clamp Selection

MT-815-S | MT-815-E | MT-815-C | MT-1921-E

Lead Selection

Rating 0.5 Seconds	10kA	16kA	25kA	45kA
Aluminium Stranded Conductor Size	55mm²	85mm²	130mm²	2 x 130mm² in parallel
Lead Lengths (m)	1 to 20	1 to 20	1 to 30	1 to 20
PVC Sheath Colours	Yellow with black stripe	Yellow with orange stripe	Yellow no stripe	Yellow no stripe

Earth Clamp Selection

MT-815-C | MT-815-C | MT-815-C

MT-847 | MT-815-S | MT-815-E | MT-815-C

PORTABLE EARTHING

Portable Earthing Configurations

■ Equipotential Bond

Single Phase Snap-on Earth Set

Typical use:

- **Equipotential bond in OH Networks where non-energised metallic parts need to be connected to earth.**

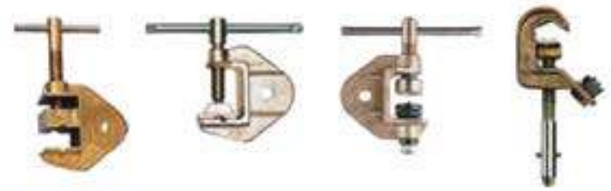
Phase Clamp Selection

MT-613/3
Snap on clamp

Lead Selection

Rating 0.5 Seconds	10kA	16kA	25kA	45kA
Aluminium Stranded Conductor Size	55mm²	85mm²	130mm²	2 x 130mm² in parallel
Lead Lengths (m)	1 to 20	1 to 20	1 to 30	1 to 20
PVC Sheath Colours	Yellow with black stripe	Yellow with orange stripe	Yellow no stripe	Yellow no stripe

Earth Clamp Selection



MT-840/1 | MT-843 | MT-847 | MT-1921-E

Hot Stick Accessories to Suit

- **MT-630 # Application Platform**
- **CRA- # Removal tool**

Where # is "C" for CATU hexagonal quick fit system, or "K" for universal sunrise fitting.

MT-630-C Application Platform | CRA-C Clamp Remover | MT-630-K Application Platform | CRA-K Clamp Remover

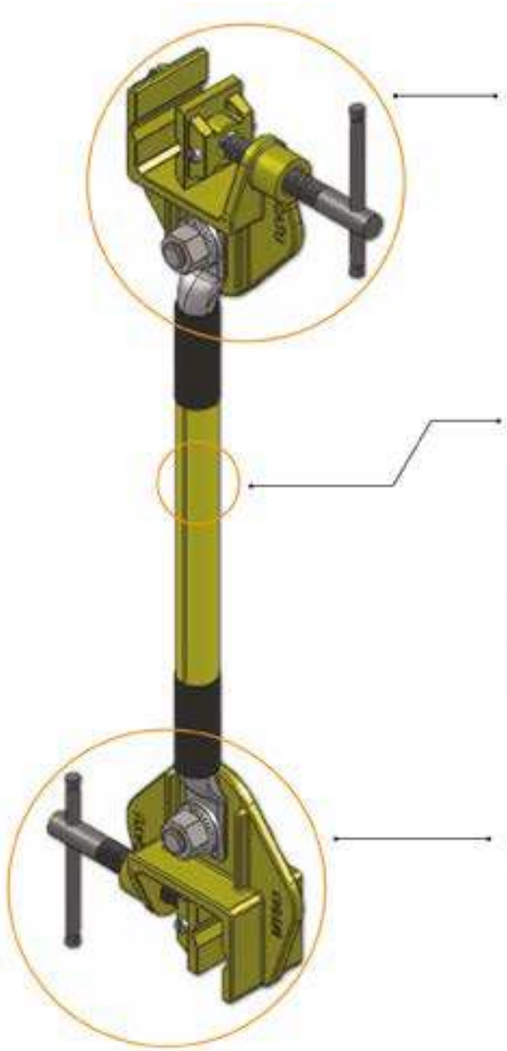
Portable Earthing Configurations

Equipotential Bond

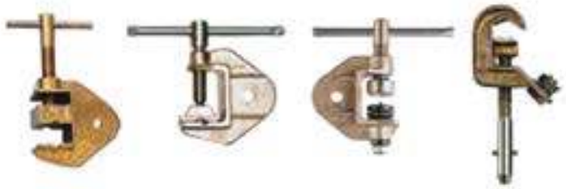
Single Phase Earth Set

Typical use:

- **Bond any metallic parts to earth. No intended for connection to normally energised apparatus. Example: Vehicle earth set.**



Clamp Selection



MT-840/1 MT-843 MT-847 MT-1921-E

Lead Selection

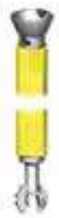
Rating 0.5 Seconds	10kA	16kA	25kA	45kA
Aluminium Stranded Conductor Size	55mm²	85mm²	130mm²	2 x 130mm² in parallel
Lead Lengths (m)	1 to 20	1 to 20	1 to 30	1 to 20
PVC Sheath Colours	Yellow with black stripe	Yellow with orange stripe	Yellow no stripe	Yellow no stripe

Earth Clamp Selection

MT-840/1 MT-843 MT-847 MT-1921-E

Portable Earthing Adaptors

Adaptor Reference Chart

	C	K	E	S	A or B
	 Hexagonal	 Universal	 Bayonet	 Clamp-Stock	 "MAJOR" Series CM-4/CM-6/CM-7
Accessories	C 	K 	E 		
Connection Adaptors	CI-7-C 	CI-3-C 	CI-6-C 	CI-5-C 	CI-3-K 
	CI-4-K 	CI-6-K 	CI-7-K 	CI-5-K 	CI-3-E 
	CI-7-E 	CI-4-E 			
Sticks	E 	A B 	K 	S 	A B 
	C 	K 	E 	S 	A B 
	K 	C 			

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