



Portable Earthing User and Maintenance Guide

ELECTRICAL+INDUSTRIAL | TOOLS+TECHNOLOGIES

TMACTM
THEW &
McCANN
GROUP

ACTIVE INNOVATION



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BEFORE YOU START

GENERAL PRECAUTIONS



Read and understand this guide before operating this equipment.

The TMAC Portable Earthing is to be used only by qualified personnel and must be used in conjunction with the user's own working and safety procedures, without compromising the integrity of the TMAC product supplied.

Follow all safety instructions contained within this guide.

QUALIFIED PERSON

A qualified person is one who is familiar with the installation, construction, operation or maintenance of the equipment and the hazards involved. In addition this person is competent, trained and authorized to undertake the work involved in accordance with established safety and working procedures.

SAFETY SYMBOLS USED IN THE GUIDE



Mandatory Action - This symbol indicates the action must be taken to avoid a hazard. Any information that follows this symbol must be obeyed to avoid possible harm.



Prohibition - This symbol indicates an action that must not be taken or must be stopped. Any information that follows this symbol must be obeyed to avoid possible harm.

GENERAL INFORMATION

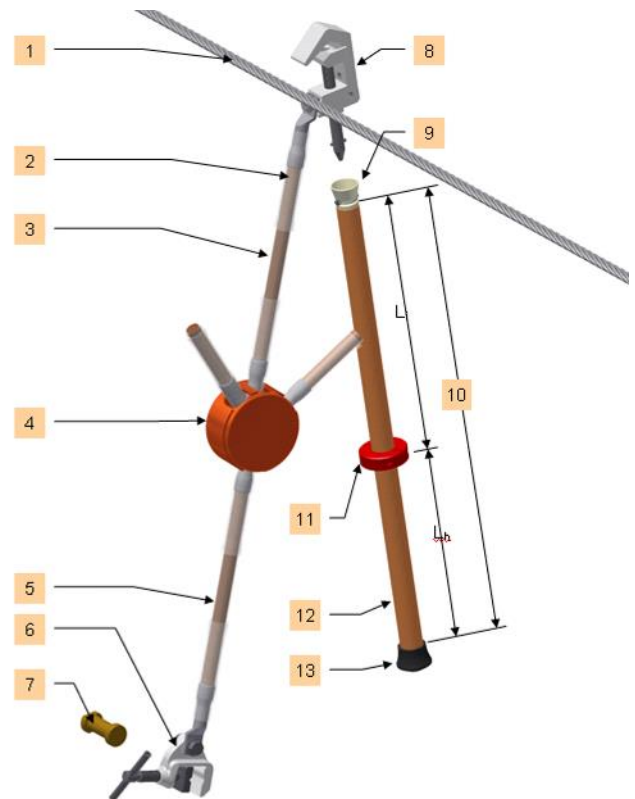
INTRODUCTION

Portable earthing and short-circuiting equipment is designed so that it will conduct fault currents between phase conductors and to earth for sufficient time to allow the circuit protection to disconnect supply. It is NOT designed to conduct fault currents continuously, but must remain electrically continuous until the circuit breaker or fuse interrupts the fault current.

Cables subjected to alternating fault currents experience extreme electromagnetic forces, causing them to move violently during the fault. The fittings and connections must be designed to withstand these mechanical forces.

EARTHING & SHORT-CIRCUITING EQUIPMENT COMPONENTS

1. Phase Connection Point
2. Stress Relief
3. Phase Cable
4. Junction Point
5. Earth Cable
6. Earth Clamp
7. Earth Connection Point
8. Phase Clamp
9. Applicator Head (for removable stick)
10. Overall Stick Length
11. Optional Hand Guard
12. Insulating Stick - Insulating part L_i , handle L_h
13. Base Cap



The connecting points to the conductors and to the earthing system must be designed to withstand the rated short-circuit and earth fault currents of the electrical installation for the required clearing time.

If required for an electrical busbar, for example, these connecting points should, wherever possible, be installed during construction of the electrical installation.

Insulating sticks must be able to support the weight of the earthing and short-circuiting cable assembly and may be either fixed to the phase clamps or removable.

APPLICATION GUIDE

CURRENT RATINGS

Every set of earthing and short-circuiting equipment has a designated rating, being a specified current for a specified time. It is required to carry this current whilst maintaining the continuity of the electric circuit between conductors and to ground for this time.

The rated current must be greater than the maximum fault current of the installation at the point of earthing. Where the service conditions for the equipment are known to be reasonable “worst-case” conditions, it is permissible to specify an equipment rating equal to the maximum fault current rating.

The rated time must be greater than the maximum fault clearing time of the protection at the fault current. The fault clearing time is calculated as the sum of -

- the protection relay operating time for the maximum fault current, plus
- any auxiliary relay operating time, plus

- the circuit breaker fault clearing time (to arc extinction)

The normal rated time is 0.5 seconds, although at other rated times different rated currents can be assigned to the equipment.

For **outdoor applications**, the equipment must carry this current whilst the cable temperature rises to a temperature in excess of 400K for Copper and 250K for Aluminium above ambient. The insulated covering on the cable may be damaged at the end of the current flow. This is NOT an indication of failure of the equipment. Many outdoor applications are on overhead lines, and since gas emission is not normally an issue for worker safety outdoors overhead earth sets are normally lighter and easier to lift and apply than substation or indoor earth sets.

For **indoor applications**, portable earthing and short-circuiting equipment is rated at a maximum temperature of 250°C, to prevent gas emission from the insulated covering on the cable which may pose a risk to personnel indoors. Therefore, for the same fault level, an indoor earth set will require a larger cable size than an outdoor earth set. It will therefore be bulkier and heavier, but of course is normally not difficult to apply at ground level.

The following table gives standard current ratings for TMAC earthing and short-circuiting cables and rated times, this should only be used as a guide. **Refer to the Rating Label on the Portable Earthing Device to determine the appropriate fault rating, as the device is rated according to the lowest rated component:**

Cable Type	Cable Cross-section mm ²	Rating kA/0.5sec or less		Rating kA/1sec		Rating kA/2sec		Rating kA/5sec	
		Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor
Copper	25	8.7	7	6.2	4.9	4.4	3.5	2.8	2.2
Copper	35	12.5	10	8.8	7.1	6.3	5	4	3.2
Copper	50	17.5	14	12.4	9.9	8.8	7	5.5	4.4
Copper	70	25	22.1	17.7	15.6	12.5	11	7.9	7
Copper	95	31.5	26.5	22.3	18.7	15.8	13.3	10	8.4
Aluminium	50	9.8	8.7	6.9	6.2	4.9	4.4	3.1	2.8
Aluminium	70	13.2	11.6	9.3	8.2	6.6	5.8	4.2	3.7
Aluminium	95	16	15	11.3	10.6	8	7.5	5.1	4.7
Aluminium	150	25	24	17.7	17	12.5	12	7.9	7.6

For **parallel applications**, simply double the rating and then de-rate by 10% in accordance with IEEE 1246 - 2011 Clause 4.8.3 "Derating of Multiple TPGs".

SERVICE CONSIDERATIONS

Users must determine the design fault level for their installation. There are several decisions to be taken in this regard -

- the maximum short-circuit current and corresponding fault clearing time;
- the maximum earth-fault current and corresponding fault clearing time (often different from the short-circuit current);
- whether the maximum currents are reasonable "worst-case" or whether a 15% margin should be allowed;
- If a lower earth fault current is allowed, acceptance of risk for the time that any neutral fault current limiting devices are bypassed; and
- A decision whether earthing and short-circuiting equipment should be rated for automatic re-closure of supply circuit breakers.

- If full rating is required when neutral fault current limiting is bypassed, or if auto-reclose is to be allowed for, then the size of the earthing and short-circuiting cables must be increased accordingly.
- A reduction of the size of the earthing cable is not permissible for equipment intended for use on multi-phase installations with a solidly-earthed neutral.

CABLE LENGTHS

When determining the lengths of cables required for the earthing and short-circuiting equipment, the configuration should be such that the cables are neither too long (whereby they may “whip” about or put unnecessary mechanical forces on the device) nor too tight as to be mechanically overstressed under electromagnetic forces.

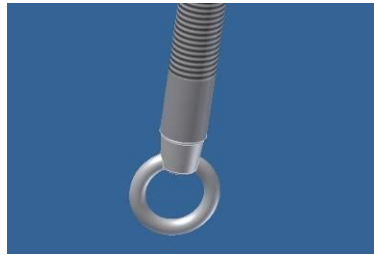
The recommended length is 20% longer than the straight-line distance between the connecting points for the installation.

SPINDLE TYPES

The following is representation of the spindle types that are applicable for TMAC Portable Earth Devices.



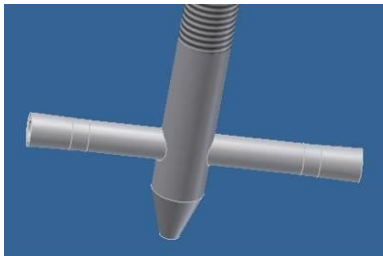
Bayonet



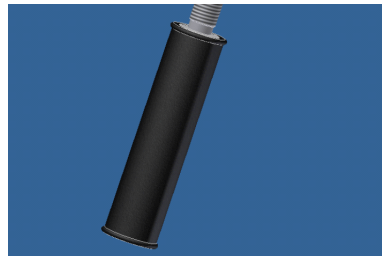
Shotgun



Taplin



T-handle



Handle






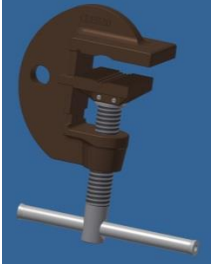

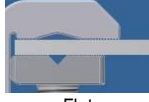












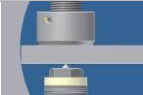
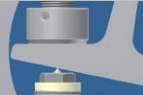

Fixed Operating Stick






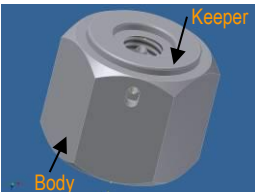
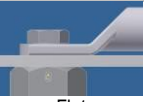
CLAMP APPLICATION

When applying a phase or earth clamp it is important to take note of the limitations imposed. Such as, the allowable conductor ranges the suitable connection type and any special requirements for installation.

The following table gives TMAC's standard range of clamps and contains important information that must be understood for the application of each clamp:

	Clamp Code	Spindle Types	Application	Suitable Connection Type	Range (mm)		Max. Rating (kA)		Application torque						
					Min	Max	0.5sec	1 sec	nm						
 <p>CLP 309</p>	TM10911	Bayonet	Phase	 <p>Round</p>	4	23	17.5	12.4	15						
	TM10913	Shotgun													
	TM10914	Handle													
		Optional Fixed Sticks													
 <p>CLE420</p>	TM10899	Bayonet	Earth	 <p>Round</p>	5	30	25	17.7	28						
	TM10898	T-Handle													
	TM10903	Handle													
				 <p>Flat</p>	10	Clamp Width	25	17.7	28						
<p>Application notes:</p> <ul style="list-style-type: none"> Suitable for Copper, Steel and Aluminium; 															
 <p>CLE820</p>	TM10907	T-Handle	Earth	 <p>Round</p>	4	35	31.5	26.5	40						
											 <p>Flat</p>	4	40	31.5	26.5
<p>Application Notes:</p> <ul style="list-style-type: none"> Suitable for Copper, Steel and Aluminium 															
 <p>CLP459</p>	TM10915	Bayonet	Phase	 <p>Round</p>	10	80	33	23.3	15						
	TM10920	Shotgun													
	TM10921	Taplin													
	TM10919	Handle													
		Optional Fixed Sticks													
 <p>CLP500</p>	TM10922	Bayonet	Phase/Earth	 <p>Round</p>	2	42	25	12.7	15						
	TM10931	Shotgun													
	TM10924	Taplin													
	TM10933	T-Handle													
	TM10930	Handle													
		Optional Fixed Sticks													

	Clamp Code	Spindle Types	Application	Suitable Connection Type	Range (mm)		Max. Rating (kA)		Application torque
					Min	Max	0.5sec	1 sec	nm
 <p>CLP500B</p>	TM10925	Bayonet	Phase/Earth	 <p>Round</p>	2	42	25	17.7	15
	TM10928	Shotgun							
	TM10929	T-Handle							
	TM10927	Handle Optional Fixed Sticks		 <p>Ballpin</p>	20	20	25	17.7	15
 <p>CLP520</p>	TM10934	Bayonet	Phase/Earth	 <p>Round</p>	2	42	25	17.7	15
	TM10937	Shotgun							
	TM10935	Taplin Optional Fixed Sticks							
 <p>CLE600</p>	TM10904	T-Handle	Penetrating Earth	 <p>Flat</p>	2	25	25	17.7	60
	TM10905	7/8" AF Hex							
					 <p>Rail</p>	2	25	25	17.7
<p>Application notes:</p> <ul style="list-style-type: none"> • Brush connection points before application to remove any loose material; • Grind cutting head into surface to break through rust or paint in a back and forth motion. Repeat at least a dozen times or more before fully tightening the clamp; • Ensure clamp is firmly tightened. 									
 <p>CLE560</p>	TM00265	Hexagonal	Phase / Earth	Round	4	35	31.5	26.5	25
	TM00266	Shotgun							
	TM00267	Bayonet		Flat	4	40	31.5	26.5	25

	Clamp Code	Spindle Types	Application	Suitable Connection Type	Range (mm)		Max. Rating (kA)		Application torque
					Min	Max	0.5sec	1 sec	nm
 <p>CLP950</p>	TM10939	Bayonet	Phase/Earth	 <p>Round</p>	2	42	33	23.3	15
	TM10946	Shotgun							
	TM10940	Taplin							
	TM10948	T-Handle							
	TM10945	Handle							
		Optional Fixed Sticks							
 <p>CLP950B</p>	TM10941	Bayonet	Phase/Earth	 <p>Round</p>	2	42	33	23.3	15
	TM10943	Shotgun							
	TM10944	T-Handle		 <p>Ballpin</p>	25	25	33	23.3	15
	TM10942	Handle							
		Optional Fixed Sticks							
 <p>CPNUT</p>	TM10967	1 3/8 Hex	Earth	 <p>Flat</p>	3	20	33	23.3	N/A

Application notes:

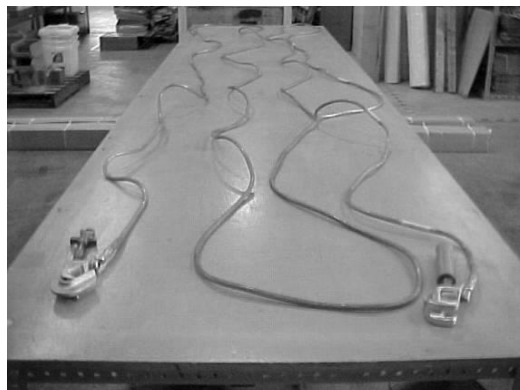
- For quick application and removal to M12 bolts;
- Bellville washers captivated inside the nut maintain contact pressure in the event of a short circuit;
- Tighten until the keeper is in line with the main body.

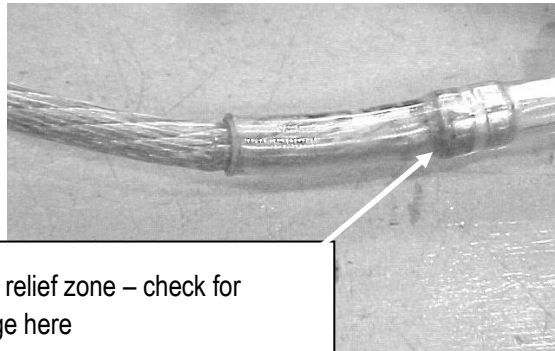
USER MAINTENANCE IN THE FIELD

General Note: Some or all of these checks and maintenance procedures may be carried out each time the portable earths are used, as appropriate to the field situation.

CABLES AND CONNECTIONS

1. Lay out cables flat to their full length. Inspect each cable for signs of insulation damage, such as cuts etc.





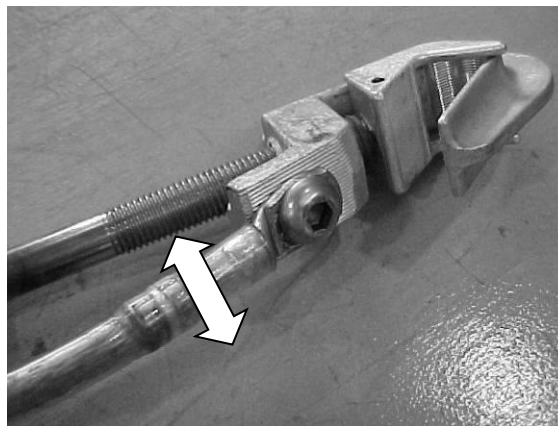
Stress relief zone – check for damage here

NOTE: The most effective and reliable way to identify damage is by visual inspection.

2. Check the Rating/Identification Labels and next test tag are in place on the cables, and are protected and legible.



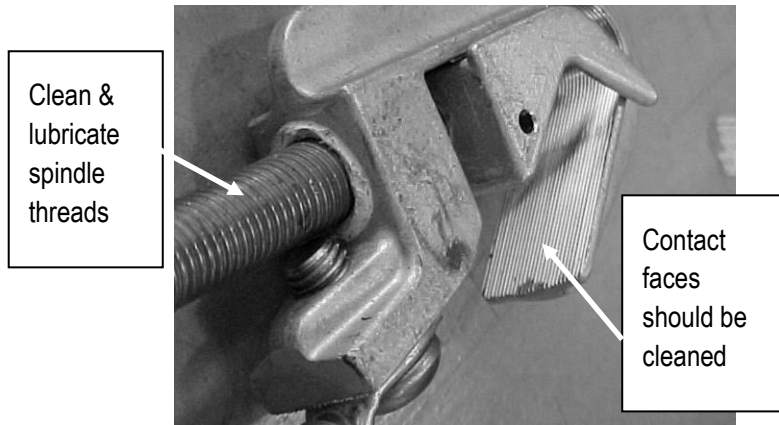
3. Check tightness of cable lugs on phase and earth clamps, hanger bar connections, and cable junctions, by shaking the cables. All connections should be tight, and no lug should move.



4. If a loose connection is found, **DO NOT** re-tighten or use the equipment. Quarantine the equipment and return for depot maintenance.

PHASE AND EARTH CLAMPS AND JUNCTIONS

1. Inspect each phase and earth clamp, and ensure all contact faces are undamaged and free of dirt and scale. Clean if necessary with a wire brush.



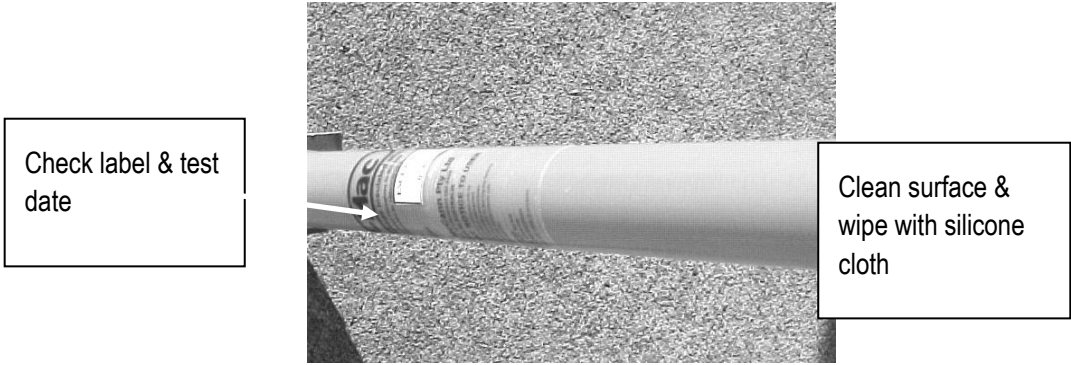
2. Check the clamp spindle and clean out any dirt in the threads. Check for excessive wear in the spindle threads.
3. Turn the spindle by hand. Each spindle should turn freely through its full travel.

NOTE: Binding threads near the limits of travel may prevent full clamping force being applied to a small or a large conductor. Under a fault, the clamp relies on a high clamping force to stay in place, and to prevent overheating due to high contact resistance which may damage the conductor.

4. Lightly lubricate spindle threads as required with a small amount of general-purpose lubricant, keeping it off the contact faces.
5. If any clamps are damaged, quarantine the equipment and return for depot maintenance.
6. Check all junctions (depending on configuration). Junctions should be tight, with all conducting parts covered by heatshrink or the junction box cover. If a junction box cover is cracked, the equipment is still serviceable, but it should be returned for depot maintenance at the first opportunity.

INSULATING OPERATING STICKS

1. Check the surface condition of fibreglass sticks for damage to the surface. Dirt and grease should be wiped off with a clean cloth.
2. Wipe the insulating stick surface with a silicone-impregnated cloth (available from TMAC) to maintain a water-repellent surface finish.
3. Check the end fittings. The base cap should be tight. The phase clamp end fitting should be clean, free of burrs (if removable bayonet type) or tightly fitted to the clamp spindle (if a fixed stick).
4. Check the label for test date to ensure it is in date. If out of test date, quarantine the equipment and return to the depot for service.



5. If any maintenance is due, or repair is required, quarantine the equipment from service and return it to the depot for workshop checking / repair.

WORKSHOP MAINTENANCE

The frequency of workshop maintenance is a matter for users to determine, based on whether portable earths are used in mobile situations (overhead line trucks) or are fixed (located in substations). This determines the amount of user damage the equipment suffers. Mobile equipment normally suffers more “wear and tear” in service than fixed equipment.

TMAC portable earthing equipment is engineered for reliable performance in the field. Our general recommendation is for workshop maintenance to be carried out every 12 months.

However, the frequency of workshop maintenance may depend on operating environment, user experience and maintenance policy. In harsh operating environments where damage rate is high, a maintenance period of six months may be appropriate.

NOTE: The most effective and reliable way to identify damage to portable earthing equipment is by visual inspection. See section on *electrical testing* below.

CABLES AND CONNECTIONS

1. Lay out cables flat to their full length. Inspect each cable for signs of insulation damage, such as cuts etc.
2. Check the Rating/Identification Labels and next test tag are in place on the cables, and are protected and legible.

NOTE: The Maximum allowable Fault Current Must be clearly identified on the PED. If it is not contact TMAC for advice and a replacement label

3. Check tightness of cable lugs on phase and earth clamps, hanger bar connections, and cable junctions. All connections should be tight, and no cable should move.

If a loose connection is found, or if a connection appears otherwise faulty, remove the clamping bolt and check the lug and palm. If OK, clean the palm and lugs, and replace the clamping bolt.

Tighten clamping bolts **using a torque wrench**. Tightening torques are –

- Phase & earth clamps – 56Nm
- Junctions – 56Nm



Mandatory Action – DO NOT OVERTIGHTEN NUTS OR BOLTS ON THE EARTH SETS

REPLACEMENT OF CABLE LUGS

TMAC portable earthing equipment includes fatigue tests on our high-reliability cable lugs. This test qualifies equipment which has been well-maintained and has no visible defects for about 5 years in mobile applications, and about 10 years in stationary applications.

After this time (depending on user experience), selected cables should be removed from service and have the lugs cut off and destructively inspected for strand breakage. Subsequent use of the cable with new lugs fitted is decided based on the condition of the cables themselves. The period before next subsequent destructive reinspection of the lugs is determined from the results of each destructive inspection.

The replacement of cable lugs requires special compression dies, and is normally carried out TMAC.

PHASE AND EARTH CLAMPS AND JUNCTIONS

1. Inspect each phase and earth clamp, and ensure the grooves in the clamp faces are undamaged and free of dirt and scale. Clean if necessary with a sharp implement.
2. Check the clamp spindle and clean out any dirt in the threads. Check for excessive wear in the spindle threads.
3. Turn the spindle by hand. Each spindle should turn freely through its full travel.

NOTE: Binding threads near the limits of travel may prevent full clamping force being applied to a small or a large conductor. Under a fault, the clamp relies on a high clamping force to stay in place, and to prevent overheating due to high contact resistance which may damage the conductor.

4. Lightly lubricate spindle threads as required with a general-purpose lubricant, keeping it off the contact faces.
5. If any clamps are damaged, remove them for repair or replacement.
6. Check all junctions (depending on configuration). Junctions should be tight, with all conducting parts covered by heatshrink or the junction box cover. If a junction box cover is cracked, it should be replaced.

INSULATING OPERATING STICKS

Insulating sticks used to apply portable earthing equipment may be either fixed to the phase clamps or removable. The earth clamp is normally applied using a tee-bar or a rubber handle fitted to the clamp spindle.

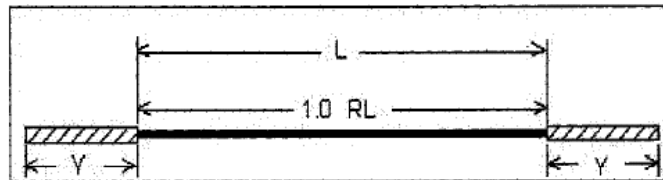
1. Check the surface condition of fibreglass sticks for damage to the surface. Excess dirt and grease should be removed.
2. If required, remove dirt and grease using acetone, allow to dry and then wipe over with a silicone-impregnated cloth (available from TMAC) to reinstate a water-repellent surface finish.
3. Check the end fittings. The base cap should be tight. The phase clamp end fitting should be clean, free of burrs (if removable bayonet type) or tightly fitted to the clamp spindle (if a fixed stick).
4. Check the label, including the test date if appropriate. If out of date, return as appropriate for electrical test of insulating stick(s).
5. If any repair or replacement parts are required, spare parts may be obtained from TMAC. If necessary, TMAC can provide support and refurbishment services as appropriate.

ELECTRICAL TESTING OF CABLES

Electrical testing of cables can be an effective method of determining cable/clamp condition *if used in conjunction with visual inspection*.

Electrical testing requirements are as follows:

- must be carried out using a micro-ohmmeter of 1% accuracy or better;
- cable temperature must be measured accurately (± 1 degree C);
- resistance measurements must be adjusted for cable temperature;
- the resistance at the time of manufacture can be used as the reference measurement; a commonly-used acceptance criterion for cable electrical testing is that the measured resistance to be not more than the **reference measurement plus 5%**.
- alternatively the calculated resistance can be used. The resistance measured should never exceed this value and can be calculated as shown.



Y = resistance of the clamp and lug to clamp contact resistance. $16\mu\Omega$

L = length of cable in meters

R = cable resistance from standard manufacturer data in $\mu\Omega$

E = $0.04R$ - allowance for measurement error in $\mu\Omega$

$R_m = RL + 2Y + E$ = maximum resistance of the cable

NOTE: The following factors affect measurement accuracy, and may render measurements inaccurate, difficult to reproduce or totally meaningless:

- no temperature correction;
- length of cable is not accurate to within a centimetre;
- measurements made through phase or earth clamps with dirty jaws;
- no reliable reference measurement for the cable.

The measurement of cable resistances is carried out using a high current micro-ohmmeter in accordance with the instructions for the micro-ohmmeter instrument to be used, and in accordance with established electrical measurement practice, taking account of the factors detailed above.

ACTIONS AFTER EXPOSURE TO A FAULT CURRENT EVENT

Any TMAC portable earthing equipment exposed to a fault current event must be removed from service and destroyed.



Prohibition – Any cable exposed to a fault must be either destroyed or returned to the manufacturer and marked with **DO NOT USE**.

REPAIR

The end user must not repair or modify any component associated with this device without written permission from TMAC.

If repair is required contact TMAC.

TMAC

45 Enterprise St Cleveland

QLD 4163 Australia

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<http://www.tmacgroup.com.au/>

DEFECTS / WARRANTY

DEFECTS

Goods are warranted to be free from defects. Provided they have been used strictly as recommended and subjected only to fair wear and tear, Goods (including parts within) which are found to be defective within 90 days after delivery to the Buyer will be repaired or replaced at the option of the Seller and at its expense. Repair or replacement by the Seller is the exclusive remedies of the Buyer.

WARRANTY

To the maximum extent permitted by law, the Seller makes no warranties, either express or implied, as to merchantability, fitness for purpose or otherwise with respect to the Goods other than in paragraph above and as required by statute. The Seller is not liable for any prospective profits or special, indirect or consequential damages or any general loss or damage, or for any expense resulting from use by the Buyer or others of defective Goods. The Seller's liability is limited to no more than the sale price of the Goods plus replacement delivery charges. Prior authority for the return of goods is required by the seller.

Please contact the seller by email sales@tmacgroup.com.au, phone 07 3826 6000 or fax 07 3826 6066 for claims related to defective / warranty of goods provided.

FOR THE FULL TERMS AND CONDITIONS PLEASE REFER TO TMAC "STANDARD TERMS OF TRADE"