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EARTHING

Introduction to Portable Earthing Devices (PEDs)

Understanding the Principles, Components, and Safety of Portable Earthing

Portable earthing devices are critical safety tools in the world of electrical engineering, especially for workers who perform maintenance or repairs on high-voltage equipment. These devices provide a temporary, reliable path for electrical current to flow safely into the ground, protecting workers from the risks of electric shock, arc flash, or accidental energisation of equipment. Understanding how portable earthing devices work, their components, and their proper usage is essential for ensuring electrical safety on worksites.

What Are Portable Earthing Devices?

Portable earthing devices—sometimes called temporary grounding sets—are mobile systems designed to connect de-energised electrical equipment or circuits directly to earth (ground) during maintenance or repair. Unlike fixed grounding systems that permanently connect certain components to earth, portable devices are used when a section of electrical infrastructure needs to be isolated and made safe for human access. These systems are especially common in high-voltage substations, transmission and distribution networks, and industrial environments.

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Why Is Portable Earthing Necessary?

Electricity always seeks the path of least resistance to the earth. When maintenance is performed on de-energised (but previously live) equipment, there is still a risk that voltage could appear on the conductors due to:

- Induced voltages: Nearby live conductors can induce voltage onto de-energised lines through electromagnetic coupling.
- Capacitive coupling: Charges can accumulate on isolated conductors, leading to hazardous voltages.
- Accidental re-energisation: Switching errors or failures can inadvertently restore power to a supposedly isolated section.
- Lightning strikes: Surges from lightning can energise an ungrounded conductor.

Portable earthing devices provide a low-resistance path to earth, ensuring that any stray voltage or current is safely diverted away from people and equipment.

Basic Components of a Portable Earthing Device

A typical portable earthing device consists of the following primary components:

- Earth clamp: A robust connector designed to attach securely to a proven earth point, such as an earth bar, ground rod, or other confirmed earthing infrastructure.
- Line clamps: Heavy-duty clamps that attach to the conductors or busbars being earthed. Their design varies depending on the type and shape of the conductor.
- Conductive cables: Flexible, highly conductive cables (often copper, sometimes aluminum) that connect the line clamps to the earth clamp. They are sized to safely carry the maximum prospective fault current.

- Insulated handles/tools: Tools and poles (aka operating poles) with insulating properties are often used to help workers attach and remove the clamps from a safe distance, especially in high-voltage environments. These are usually manufactured in sections which can be connected with button joints (a sectional pole) or designed to be expanded with a telescopic mechanism (a telescopic pole).
- Identification and safety markers: Tags, warning signs, or covers to make the presence of the earthing device obvious to all workers in the area.

Principles of Operation

The operation of a portable earthing device is straightforward, but must be carried out with strict adherence to safety procedures. The device works by physically connecting the isolated (but potentially energised) conductor to a low-resistance path to earth. This way, if voltage does appear—due to induction, accidental energisation, or other reasons—the current will flow directly to ground, minimising the risk to workers.

The main objectives are:

- To rapidly discharge any static or induced charges on the conductor.
- To provide a safe, predictable path for current if the line is accidentally energised.
- To ensure that the potential difference (voltage) between the conductor and earth remains at a safe level—ideally zero.

Step-by-Step Use of Portable Earthing Devices

The procedure for applying a portable earthing device typically involves the following steps:

1. Confirm Isolation and Test for Absence of Voltage

Before installing any earthing devices, the equipment must be fully isolated from all sources of electricity. Using an appropriately rated voltage detector, confirm the absence of voltage. This is a crucial safety step—never assume a line is dead without testing.

2. Clean the Connection Points

Both the earth point and the conductor to be earthed should be clean and free of corrosion, paint, or debris, ensuring a reliable electrical connection.

3. Attach the Earth Clamp First

Always connect the earth clamp to the verified earth point before attaching to the line. This practice ensures that the cable is already connected to earth before any potentially dangerous actions take place.

4. Attach the Line Clamp(s)

Using insulated tools or poles, attach the line clamps to the de-energised conductor(s). In multi-phase systems, each phase to be worked on should be connected to earth. The

process should always be carried out from a safe position, ideally standing on insulating matting.

5. Visual Check and Tagging

Once the earthing device is installed, visually inspect all connections. Place warning signs or tags to indicate the presence of temporary earthing equipment.

6. Removal Procedure (Reverse Order)

When the work is completed and the area has been confirmed as safe, the earthing device is removed in the reverse order: disconnect the line clamps first, then the earth clamp.

CAUTION: The circumstances and situations where PEDs vary greatly. Your organisation will have standard operating procedures (SOPs) that will describe how PEDs are to be applied and removed in more detail. In all cases, these SOPs should overrule the generic step by step procedure we described above.

Key Safety Considerations

Portable earthing devices are only as effective as the procedures governing their use. Key safety principles include:

- Correct Sizing: The earthing cables and clamps must be rated to carry the maximum possible fault current for the duration of the fault until protective devices operate.
- Proper Selection: The right type of clamps and cables must be matched to the specific application and equipment being earthed.

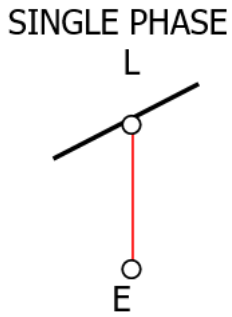
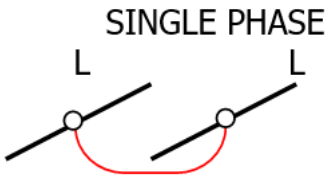
- Inspection and Maintenance: Devices must be regularly inspected for wear, corrosion, or damage, and replaced as necessary.
- Training: Only qualified personnel who have been trained in safe earthing procedures should install or remove these devices.
- Testing: Each use should begin with testing both the earth and the conductor to be certain of their status—never skip this step.
- Documented Procedures: All applications should be covered by formal site procedures and risk assessments.

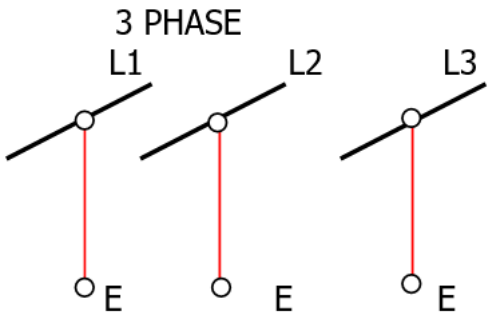
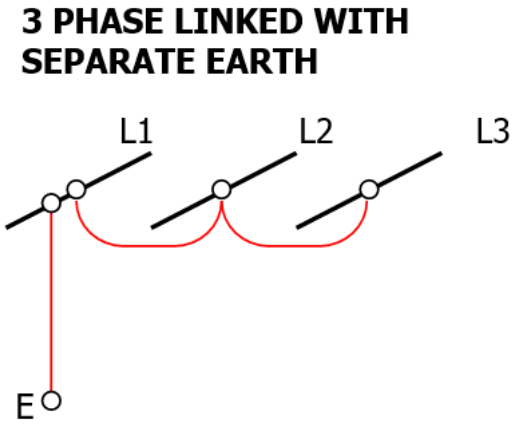
Common Configurations of Portable Earthing Devices

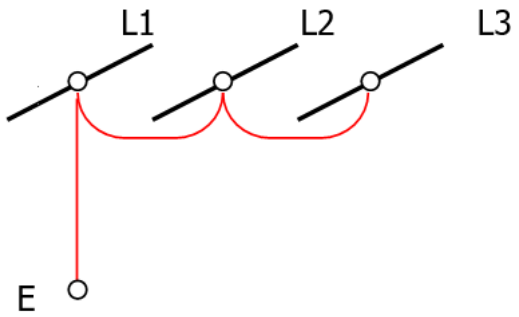
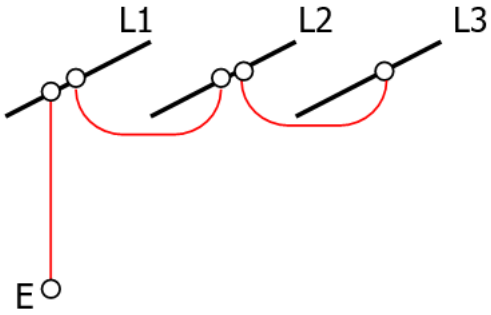
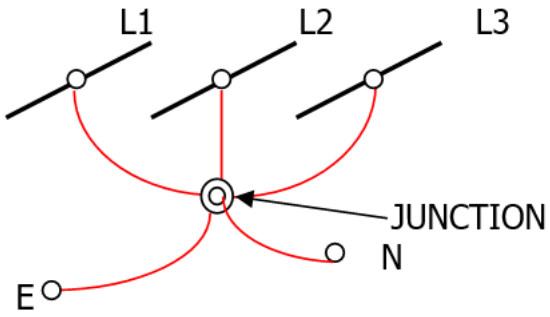
The most common portable earthing device consists of

1. A clamp or other device for attaching the PED to a de-energized conductor.
2. A cable to carry the short circuit or fault current.
3. A clamp or other device to either connect to another de-energized conductor, to a neutral terminal or to another metal object connected to earth or ground.

Based on this basic PED, several configurations of portable earthing devices can be built up to make up a set, each designed for specific applications:

For Transmission Network applications, 66kV and above, require earth leads with much greater higher fault currents and longer cable lengths. Together, they result in much heavier equipment. In order to make application and removal practical, individual phase to earth leads make up a set.	
Phase to phase bonding can be a step in applying an portable earthing device set to an isolated or de-energized system, using a single earth lead with line clamps at both ends.	

Using individual line clamp, cable and earth clamp combinations, all three phases can be earthed. All three individual earth leads can then be kept together for as a set for easy transporting to the field.	
This configuration bonds or short circuits the phases together with a separate earth line. This configuration is commonly seen with snap-on clamps. These clamps are often mounted using an applicator tool which lifts all three clamps up at the same time. This configuration reduces the weight carried by the applicator because the earth line and its line clamp is not lifted at the same time. It requires a clamp that supports two cables being connected to it at the same time.	

This configuration can also be seen with sets that use snap-on clamps. It reduces costs because one less clamp is required than the previous configuration. This configuration uses two clamps that support two cables connected to each at the same time.	**3 PHASE LINKED WITH SEPARATE EARTH** 
This configuration is useful where higher fault currents are expected and so heavier cables are required. To keep the weight down, each device in a set is applied separately. However this configuration requires five separate clamps, while keeping to only one earth clamp.	**3 PHASE WITH SEPARATE EARTH** 
The 3 phase with junction block configuration is typically used for voltages up to 66kV. They encompass a number of phase lines connected to a central junction with a trailing earth. They provide provision for connection to the neutral or for bonding purposes. This configuration is more cost effective because it reduces the amount of cable required by individual single phase PEDs.	**3 PHASE WITH JUNCTION BLOCK PLUS EARTH & NEUTRAL** 
As you can see, a single phase PED can be used as a building block to create any number of custom configurations that may be kept together in the field to form a PED set. For complex systems, devices may be custom-built to suit unique equipment or busbar arrangements.	

Practical Applications

Portable earthing devices are employed wherever workers must enter areas that are normally energised, such as:

- High-voltage transmission and distribution lines during maintenance
- Substation busbars and switchgear
- Industrial electrical panels
- Railway electrification systems
- Temporary earthing for construction or emergency repair work

In each case, the devices are selected and installed according to the particular equipment, voltage level, and fault current expectations.

Common Mistakes and Hazards

Even with proper equipment, mistakes in applying portable earthing can have tragic consequences. Common errors include:

- Failing to test for voltage before application
- Applying the line clamp before the earth clamp
- Using undersized cables or damaged equipment
- Improper connection points—attaching to painted or corroded surfaces
- Inadequate training or supervision

Each mistake can compromise the effectiveness of the system and put workers at risk of electric shock or fatal injury.

Specifying PEDs

You'll need to know:

1. What conductors or objects you want to connect the PED to. This will guide you on how to select the device or clamp you need to make a good electrical connection. Check for the maximum thickness of whatever you need to connect to. Manufacturers will often specify what the minimum and maximum thickness of an object their clamps can be applied to. For example, our Line Clamp 38 can connect to any conductor with an outside diameter up to 38mm.
2. The amount of current the PED needs to carry, usually measured in thousands of Amps (kA).
3. The duration the PED needs to survive before a protection device such as a circuit breaker, activates. This usually measured in seconds or numbers of cycles of an AC system.
4. What the earthed object is that you want to connect the PED to. This will tell you want device or clamp you need to make a good electrical connection. Check for the maximum thickness of whatever you need to connect to.

Relevant Standards

The following standards govern the construction, testing and maintenance of portable earthing devices and their components:

IEC 61230 This standard focuses on portable equipment for earthing and short-circuiting. It specifies requirements for the design of complete portable earth systems, including clamps, cables, and testing procedures.

IEC 61138 This standard specifically addresses flexible cables used for portable earthing and short-circuiting equipment. It defines cable types, code designations, and testing methods to ensure reliability and safety.

Earth sticks In New Zealand, the standards governing the use of earth sticks and operating poles in electrical work are primarily found within the Electricity (Safety) Regulations 2010, specifically Regulation 60 which references earthing requirements for works, and Regulation 42 regarding earthing systems in works. These regulations are supplemented by the New Zealand Electrical Code of Practice for Power Systems Earthing (NZECP 35:1993). Additionally, NZECP 46:2003 provides guidance on live line work, including the use of stick, glove and barrier, and barehand techniques.

You should make sure that your manufacturer states that their equipment or cable meets these standards.

Cables

At Betacom Earthing we provide the following cables. Each cable is carefully selected for strand diameter, cluster numbers and lay length to optimize conductivity, durability and flexibility.

Cable Crossectional Area (mm2)	Metal	Tested to
25	CU	6kA, 1s
35	CU	10kA, 1s
50	CU	16kA, 1s
147	AL	25kA, 1s

We favour copper cable over aluminium cable because of its better ability to withstand fatigue. However we also recognize that weight is a key consideration thus our 147mm2 AL cable is popular among our transmission network customers.

Any system is only as effective as its weakest component. In PEDs this is usually the cable assembly. Thus when we quote a fault current for the cable, you can be assured that the entire system is able to carry that much current for the specified duration. When we test, the entire system, that is, clamps, cables and connections are all tested together.

Maintenance and Testing

Our customers often talk about how our equipment passes inspections without need for repair even after more than a decade of frequent use.

In New Zealand, its recommended by the Electricity Engineers Association (EEA) as standard practice for PEDs to be visually inspected for damage or excessive wear every six months and electrically tested every three years.

We recommend that these standards are strictly adhered to.

Visual inspection	Every six months
Electrical testing	Every three years

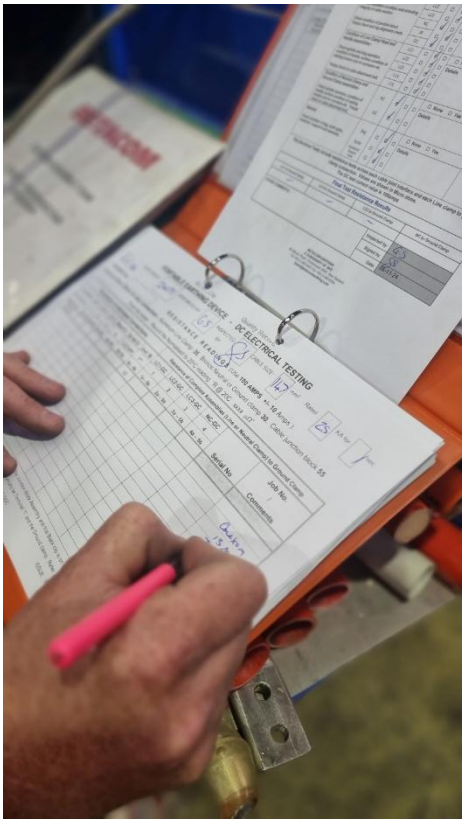
Visual inspections

Look for:

- Discoloration from water ingress
- Discoloration from having previously carried a heavy current
- Discontinuities in the way the bundles of strands are packed within the insulation.
- Insulation that has “walked” out from beneath the lug exposing bare conductor
- Broken strands, kinks, twists or excessive bending
- Obvious damage, holes, cracks, corrosion
- Stiff spindles
- Deformed clamps
- Damage to button joints
- Loose connections
- All warning labels indicating the maximum load and other safety information are there and clear
- Dedicated earthing equipment should be clearly marked “FOR EARTHING ONLY”

Electrical Testing

Measure the resistance of the PED set from the line clamp to the end of the earth clamp.



It may be necessary to use a wire brush to remove any oxidized surfaces so that a good electrical connection can be made with the ohmeter.

Your network provider's technical staff should be able to provide you with industry guidelines on maximum resistance values, corrected for ambient temperature.

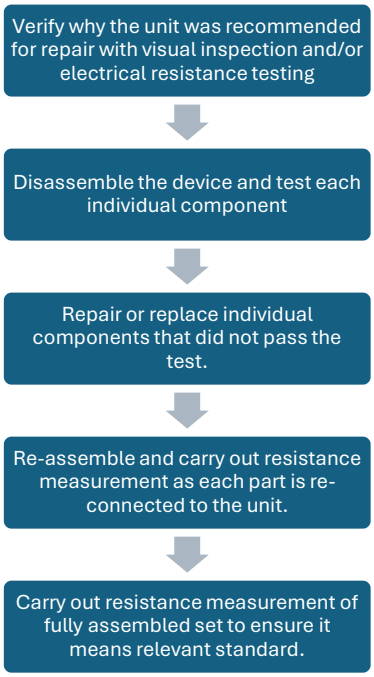
Under IEC 61230, the ohmmeter should be capble of measuring micro-ohms to 1% accuracy.

Operating poles should be subjected to a high voltage test, typically 100kV per 300mm, to prove that their insulating capability and protect users.

Repairs

Repairs should be carried out according to the manufacturer's instructions.

In general, the repair process should follow the following steps:



More questions?

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