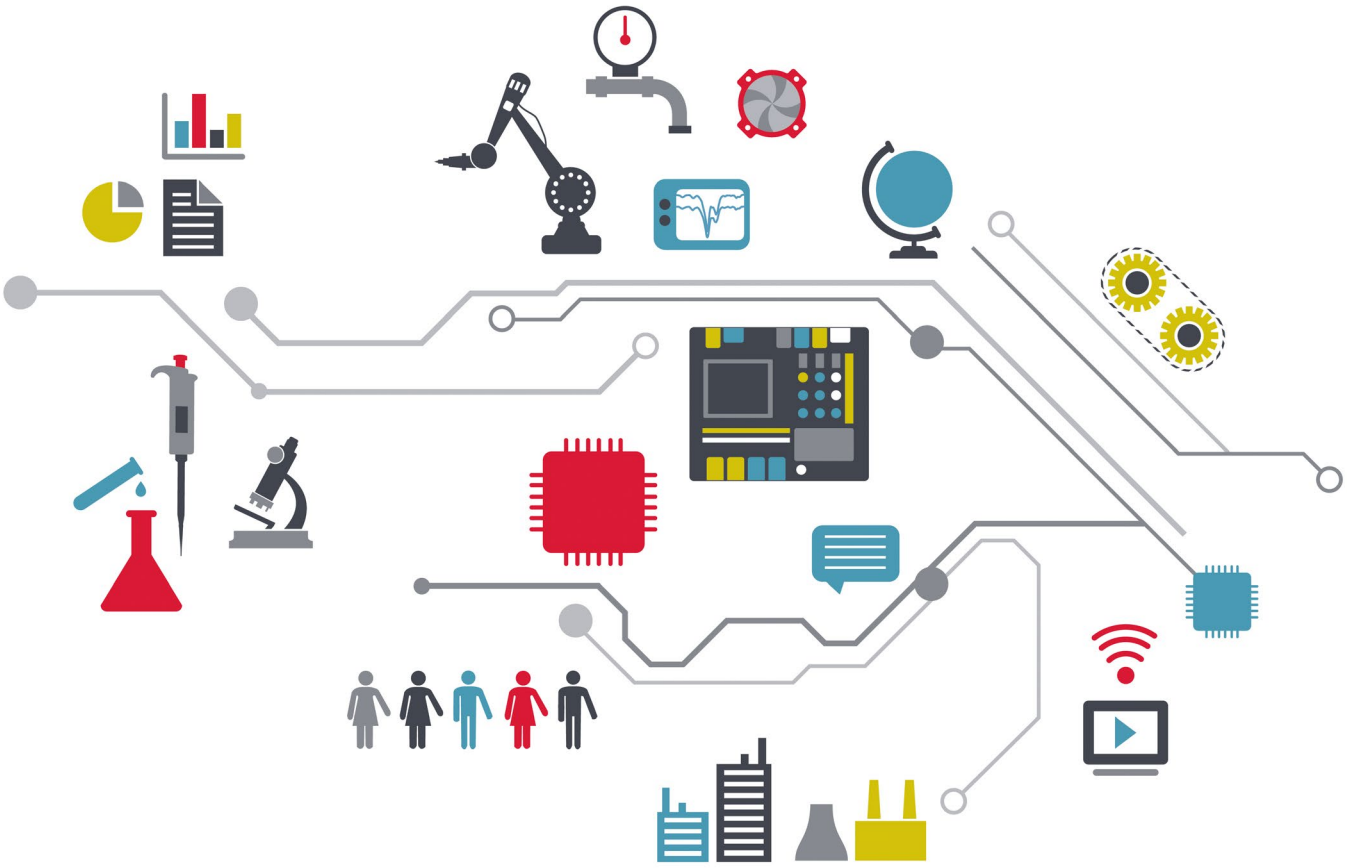
GAMBICA

Guide to Overvoltage Categories & Measurement Categories

A GAMBICA Technical Guide



GAMBICA

1 Overvoltage Category

Overvoltage categories are defined by a Roman numeral according to the potential for transient overvoltage to occur. Overvoltage categories are created to determine the required insulation strength of the components and equipment used within the low-voltage mains supply system.

Equipment forming part of the building installation will include insulation material, equipment intended to protect, measure or control the mains supply within the building, and similar equipment. All such equipment is permanently connected to the mains and is permanently installed in the building. However, equipment that utilizes the mains supply only for powering itself and associated equipment is not considered to be part of the building installation, even if it is permanently connected or permanently installed in the building.

Overvoltage categories are defined in IEC 60364 as follows:

Overvoltage Category I
is used for equipment intended to be connected to a mains supply in which means have been taken to substantially and reliably reduce transient overvoltages to a level where they cannot cause a hazard.

Overvoltage Category II
is for equipment intended to be supplied from the building wiring. It applies both to plug-connected equipment and to permanently connected equipment.

Overvoltage Category III
is for equipment intended to form part of a building wiring installation. Such equipment includes socket outlets, distribution boards, and some mains installation control equipment. Manufacturers may also design equipment for overvoltage category III when a higher degree of reliability and availability is desired.

Overvoltage Category IV
is for equipment installed at or near the origin of the electrical supply to a building, between the building entrance and the main distribution board. Such equipment may include electricity tariff meters and primary overcurrent protection devices. Manufacturers may also design equipment for Overvoltage Category IV when an even higher degree of reliability and availability is desired.

2 Measurement Category

Measurement category is a means of classifying the terminals of test and measurement equipment according to the type of mains circuit to which they are intended to be connected. Measurement categories take into account overvoltage categories, short-circuit current levels, the location in the building installation where the test or measurement is to be made, and some forms of energy limitation or transient protection included in the building installation.

Measurement categories are defined in IEC 61010-2-x and are summarized here:

Measurement category II
is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points but excluding installed lighting) of the low-voltage mains installation. Examples include measurements on mains circuits of household appliances, portable tools and similar equipment, and on the consumer side only of socket-outlets in the fixed installation. Short circuit currents are typically below 10kA, depending on the characteristics of the installation.

Measurement category III
is applicable to test and measuring circuits connected between Measurement category II and Measurement category IV of the building's low-voltage mains installation. To avoid risks caused by the hazards arising from higher short-circuit currents, typically up to 50kA, depending on the characteristics of the installation, additional insulation and other provisions are required. For equipment that is part of a fixed installation, the fuse or circuit breaker of the installation must provide adequate protection against short-circuit currents. Examples include measurements on distribution boards (including secondary meters), photovoltaic panels, circuit-breakers, cables, bus-bars, junction boxes, lighting, switches, wiring to socket-outlets, equipment for industrial use and some other equipment (such as stationary motors) with permanent connection to the fixed installation.

Measurement category IV
is applicable to test and measuring circuits connected between the source of the building's low-voltage supply and the first accessible isolator switch able to disconnect all line and neutral connections. The high potential short-circuit currents, typically greater than 50kA, depending on the characteristics of the installation, existing in these circuits can create an extremely dangerous, high energy arc flash through any accidental short-circuit caused whilst making measurements. Precautions must be taken to avoid any chance of a short-circuit. Examples include measurements on the unisolated conductors at the isolator switch, the tariff meter, service fuse and low voltage devices installed in the sub-station.

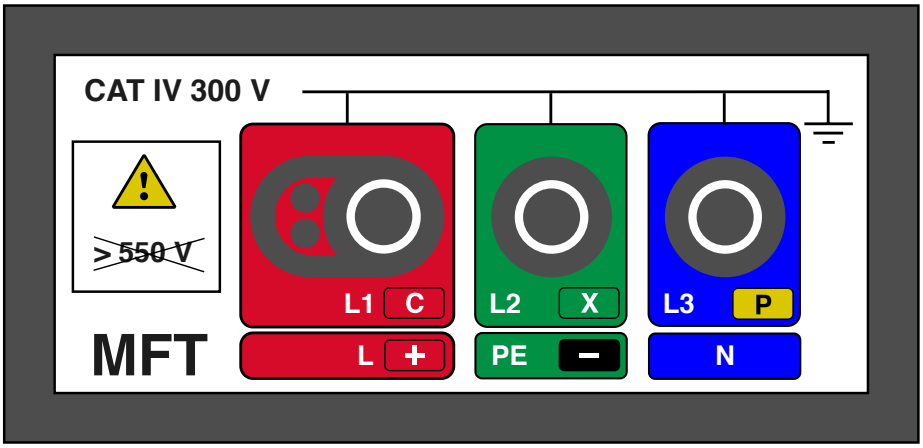
3 Measuring Circuits Without a Measurement Category Rating

Many types of test and measuring circuits, although not intended to be directly connected to the mains, may have very high amounts of available energy from high short-circuit currents or high open-circuit voltages. There are no standard transient levels defined for these circuits. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in these circuits is necessary to determine the insulation requirements and short-circuit current requirements. Examples include thermocouple measuring circuits, high-frequency measuring circuits, automotive testers, and testers used to prove the mains installation before it is connected to the mains supply.

4 Test Instrument Selection

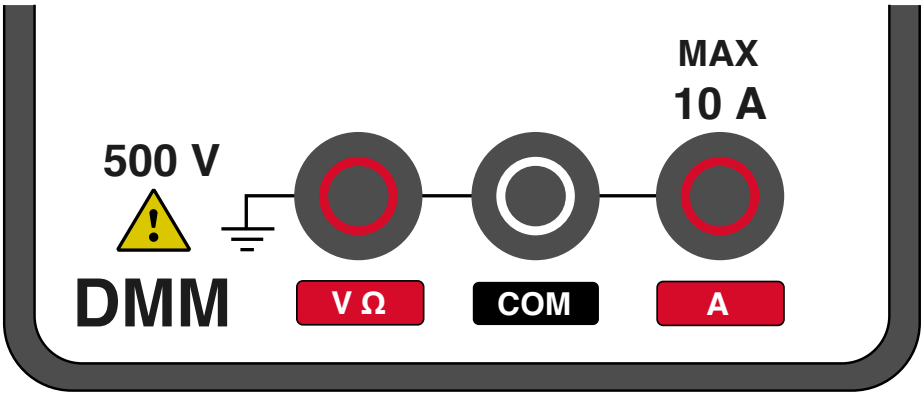
It is important that an instrument with an appropriate measurement category is used when making measurements on mains circuits. Figure 1 (page 9) shows the measurement categories specified for various parts of an installation.

The safety standard for test and measurement equipment, BS EN61010, requires that terminals are marked with the value of the rated voltage to earth and the applicable measurement category, often abbreviated to "CAT." Measurement terminals can be safely connected to a measurement category lower than the marking on the terminals. The measurement terminals must never be connected to a circuit that exceeds the rated voltage or measurement category.



This typical multifunction tester terminal panel is rated for CAT IV 300 V measurement connection. Measurement connection to CAT IV, CAT III or CAT II circuits may be made provided voltage does not exceed 300 V with respect to earth. Measurement connection not exceeding 550 V between phases may be made provided no voltage exceeds 300 V with respect to earth.

The ⚠ triangle refers the operator to the user instructions where more detailed information on the ratings may be given, along with other hazards, such as unmated terminals becoming live from high voltage within the instrument.

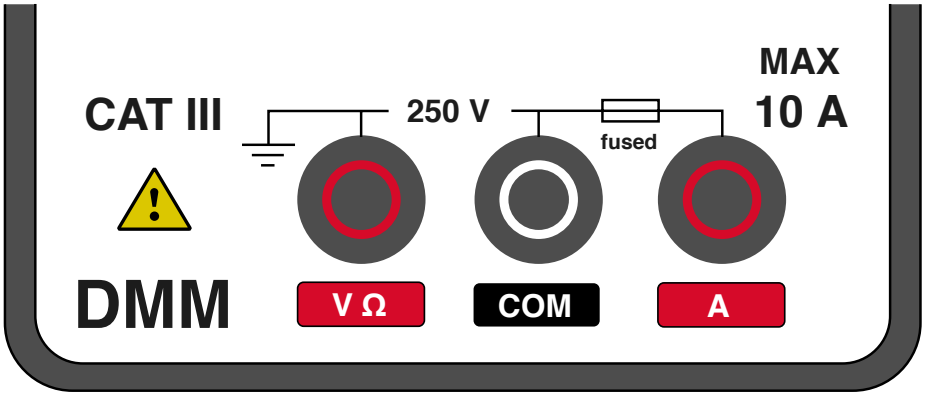


This typical multimeter terminal panel is rated for measurement connection up to 500 V with respect to earth.

There is no CAT rating, so this instrument must not be connected to the mains even though the rated voltage is greater than the nominal domestic supply voltage.

The ⚠ triangle refers the operator to the instruction manual for more information.

Instruments and test leads with no CAT rating must have a warning in the instructions not to connect to the mains supply - but some manufacturers overlook this requirement.



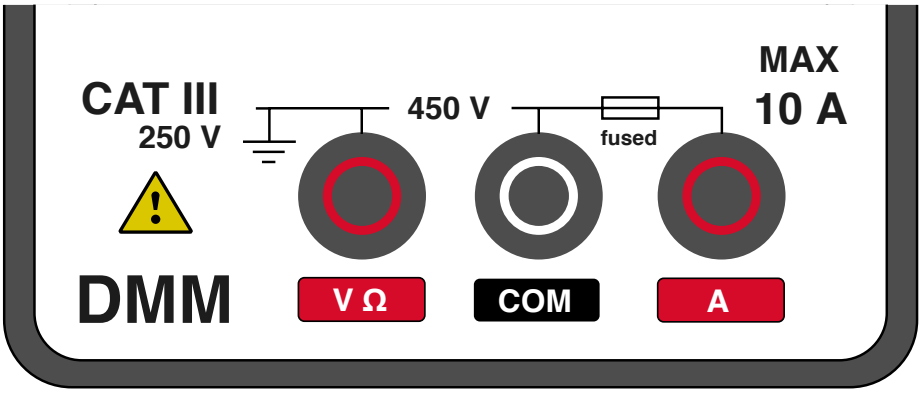
This multimeter is rated for mains measurement connection up to CAT III 250 V with respect to earth and 250 V between terminals.

Measurement connection to CAT III or CAT II circuits may be made provided voltage does not exceed 250 V with respect to earth and does not exceed 250 V between terminals.

This instrument must not be connected to voltage higher than 250 V across phases.

Measurement connection to CAT IV circuits must NOT be made at any voltage.

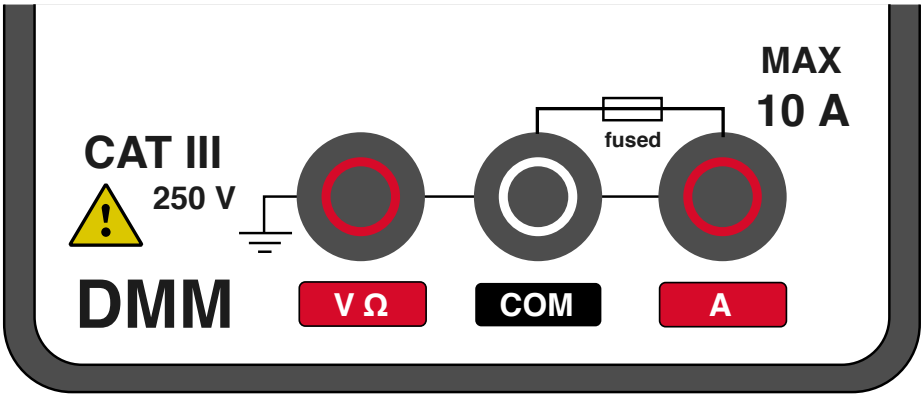
GAMBICA



This multimeter is rated for mains measurement connection up to CAT III 250 V with respect to earth and 450 V between terminals.

Measurement connection to CAT III or CAT II circuits may be made provided voltage does not exceed 250 V with respect to earth and does not exceed 450 V between terminals. This instrument must not be connected to voltage higher than 450 V between phases.

Measurement connection to CAT IV circuits must NOT be made at any voltage.



This multimeter is rated for mains measurement connection up to CAT III 250 V with respect to earth.

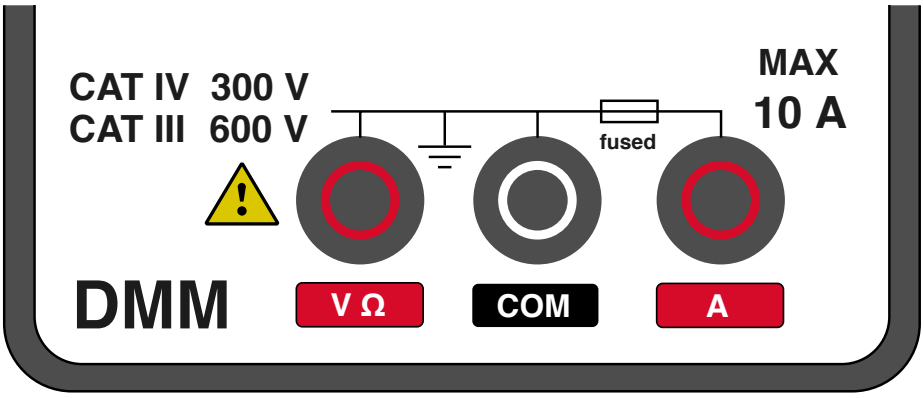
Measurement connection to CAT III or CAT II circuits may be made provided voltage does not exceed 250 V with respect to earth.
It cannot be taken for granted that this instrument may be connected to voltage higher than 250 V between phases. Often there is insufficient space for all ratings to be marked.

The ⚠ triangle refers the operator to the instruction manual for more information

Measurement connection to CAT IV circuits must NOT be made at any voltage.

Note that one cannot 'trade-off' CAT rating and voltage: connecting to a CAT circuit higher than the instrument rating but with half the instrument's voltage rating, or vice-versa: connecting to a voltage higher than the instrument is rated but at a lower measurement category.

Dual-rated instruments permit this 'trade-off' but, unless it is specified on the instrument or the user instructions, it is unsafe to do so.

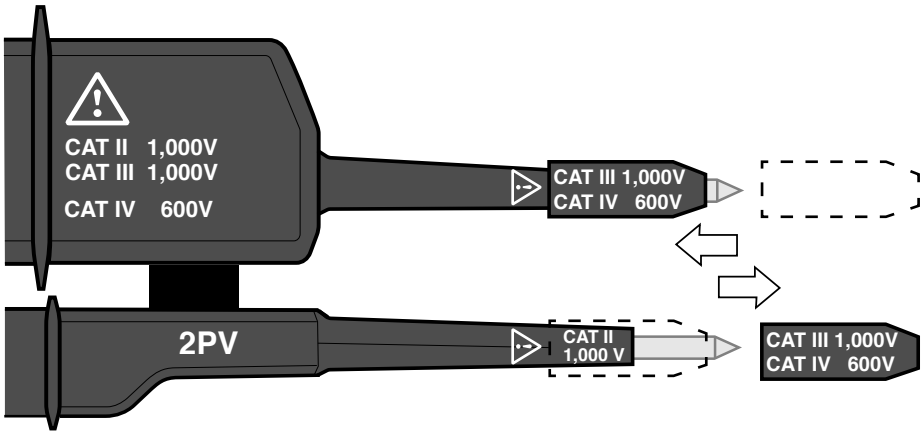


This multimeter is dual rated for mains measurement connection up to CAT IV 300 V with respect to earth, and to CAT III 600 V with respect to earth.

Measurement connection to CAT III or CAT II circuits may be made provided voltage does not exceed 600 V with respect to earth.
It must not be taken for granted that this instrument is safe to connect to a CAT III voltage higher than 600 V between phases. There is often insufficient space on an instrument to place all rating information.
The ⚠ triangle refers the operator to the user instructions.

Measurement connection to CAT IV circuits may be made provided voltage does not exceed 300 V with respect to earth.

It must not be taken for granted that this instrument is safe to connect to a CAT IV voltage higher than 300 V between phases. The ⚠ triangle refers the operator to the user instructions where more detailed safety information is given.



This two-pole voltage detector is rated for measurement connection to CAT II 1,000 V, or CAT III 1,000 V and CAT IV 600 V.

This is achieved with detachable insulators on the probes. When the insulators are in place only a small length of each tip is exposed and the risk of one of them accidentally short-circuiting between conductors is much reduced. The insulated tip is safe to use in higher energy CAT III and CAT IV circuits as marked.

When the insulators are removed the tips are longer than permitted for safe high energy connections. The risk of short-circuit is higher and the exposed tip is safe to use only in protected, lower energy CAT II circuits as marked. It is important to note that if the exposed tip is a 4 mm unshrouded 'banana' plug, it must not be used to attach crocodile clips or other probes.

The probes are designed so that the higher marked rating is removed with the insulator and reveals the lower rated marking. This feature is seen on multiple rated test probes as well. There is often insufficient space at the measurement terminals so the key ratings are marked on the instrument body and the ⚠ triangle refers to operator to the user instructions.

GAMBICA

4 Location of Measurement Categories

CAT Ratings

BS EN61010-1 Installation Categories (CAT ratings) define the risks from hazardous transient impulses and potentially lethal short circuit currents on the mains supply system based on where you are working.

Voltage Ratings

Test equipment used for measuring mains circuits will have a CAT rating to show where it can be used. Each category also has a voltage rating to show the maximum safe phase to earth system voltage, normally 50V, 100V, 150V, 300V, 600V or 1000V.

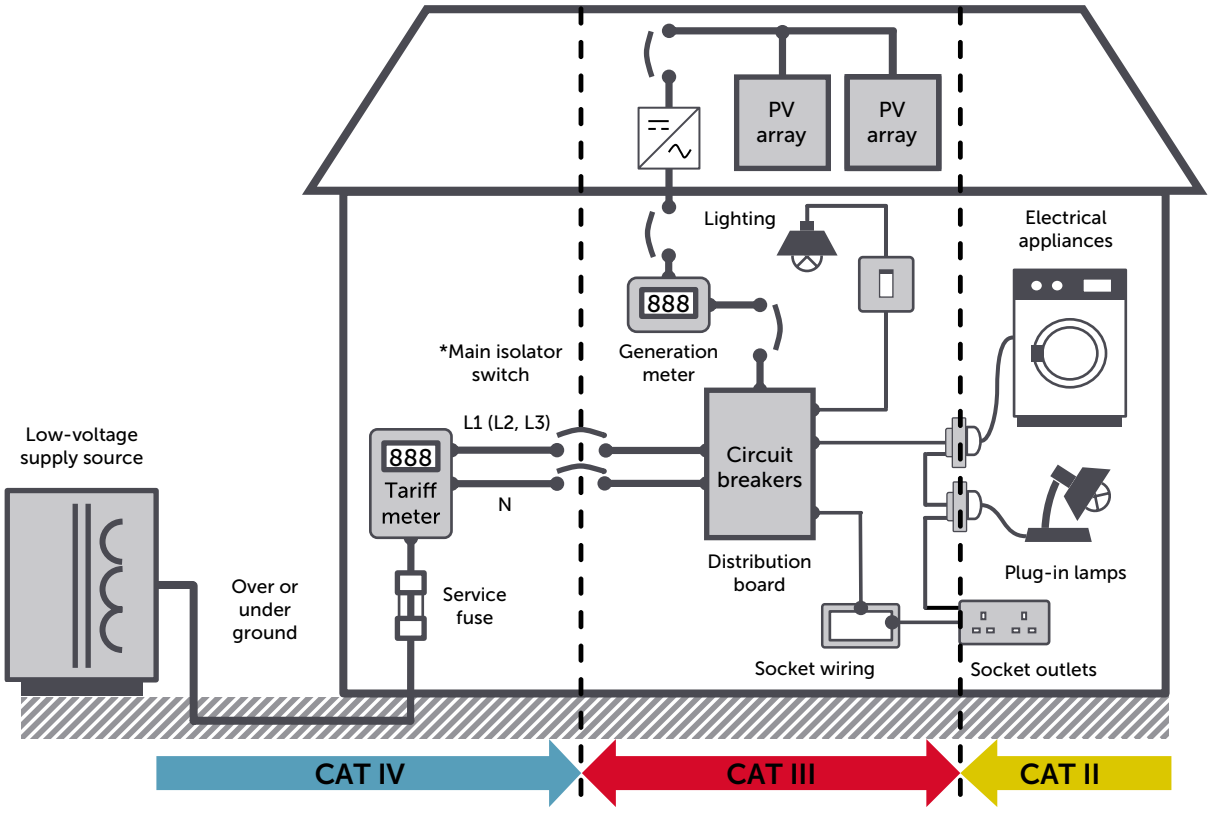
Match your test equipment safety rating to the installation category.

CAT II socket outlets and similar points of the mains installation.
CAT III the distribution part of the building's mains installation.
CAT IV the supply side source of the building's mains installation.

Testers, leads and accessories all need safety ratings equivalent to, or higher than the installation category and voltage rating for the location to be safe.

Figure 1 Location of Measurement Categories

*The main isolator switch may be installed by the service provider. If not, the demarcation point between CAT IV and CAT III is the first isolating switch in the distribution board.



Footnote: In some installations the main isolator switch may be the device provided by the DNO. Where this is not the case it will be on the distribution board.

The GAMBICA Association Ltd

Rotherwick House,
3 Thomas More Street,
London E1W 1YZ

T + 44 (0) 20 7642 8080
E info@gambica.org.uk
W gambica.org.uk

Version 1.1