DOWNLOAD PDF MEASUREMENT OF ELECTRIC CURRENTS.

Chapter 1 : Measurement of Current

An electric current is a flow of electric charge. [1]: 2 In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in an ionised gas (plasma).

The electric current is the rate of flow of electric charge through a conducting medium with respect to time. When there is a potential difference appeared between two points in a conductive medium electric charge starts flowing from higher potential point to lower potential point to balance the charge distribution between the points. The rate of flow of charge in respect of time is known as electric current. Current Formula If q Coulomb electric charge gets transferred between these two points in time t sec, then the current can be calculated as In differential form, the current can be represented as Unit of Current As the current is the ratio of transferred charge to the time taken for this charge transferring we can say one unit current is such a rate of charge transferring in which one Coulomb charge is transferred from one point to another in one second. This is SI unit of electric current. Theory of Electricity Current in Metallic Conductor The main cause of current through a metallic substance is the flow of electrons that is the directional drift of free electrons. In metal, even at room temperature, there are plenty of free electrons exist inside the metallic crystal structure. When electric potential between two points in the metal differs the free electrons which were randomly moving at equilibrium potential condition and also the free electrons supplied by the source if a source is connected between these two points now get drifted towards higher potential point due to electrostatic attraction. As each of the electrons has a negative charge of - 1. The rate of flow of this negative charge in respect of time is the current in the metal. Conventional Direction of Current Although the flow of electrons or negative charge is from lower potential point to higher potential point but the conventional direction of current is considered from higher potential to lower potential. Although current is mainly caused by the flow of electrons that is the flow of negative charge but previously it was thought that the electrical current is due to the flow of positive change. But now it is proved that the current in a metallic conductor is due to flow of electrons or negative charge but the direction of current is still considered as it was accepted previously that is opposite of flow of electrons. The direction of the current which is considered from a higher potential point to a lower potential point is known as the conventional direction of current. Types of Current Direct Current When current flows in one direction either in constant or fluctuating manner the current is called direct current. Alternating Current When current flows in either direction alternatingly in a frequency is called alternating current. The average value of an alternating current is zero. The alternating current is measured in RMS value. One main parameter of alternating current is frequency. Magnetic Effect of Current When current flows through a conductor there will be a magnetic field surrounding the conductor. The direction of the lines of force of the magnetic field can be determined by right-hand grip rule. If we imagine that we have held the current carrying conductor with our right hand with extended thumb along the direction of the current then four fingers of our right hand indicate the direction of lines of force of the magnetic field. When we make a coil with a conductor and current flows through the coil then due to magnetic effect of each conductor of the coil there will be an overall magnetic field surrounding the coil. Here we can also determine the direction of the field by right-hand grip rule. If we hold the current carrying coil with our four fingers along the direction of current in the turns of the coil then the extended thumb indicates the direction of the magnetic field. Current in Magnetic Field When we place a current carrying conductor or a current carrying coil in a magnetic field, a mechanical force acts on the current carrying conductor or coil. This mechanical force depends on the current through the conductor or coil. Measurement of Current Depending on the principle of interaction between current and magnetic field one can measure the current. One of the basic instruments to measure the current is pmmc instrument or permanent magnet moving coil instrument. The pmmc instrument is only able to measure direct current. The alternating current can be measured by moving iron instrument where magnetic field created by current through the instrument coil causes movement of a soft iron piece either by attraction or repulsion force. This instrument can also measure direct current. Rectifier type instruments are also used to measure alternating current. Here bridge rectifier is used to rectify alternating current then it is measured with pmmc instrument. Wherever may be the types of current measuring instrument in one word all current measuring instruments are called ammeter. An ammeter is always connected in series with the path of which the current to be measured. When very high current is to be measured we use current transformers to step down current for measuring purpose. Heating Effect of Current When current flows through a conductor there is a heating effect in the conductor. The loss of power in the conductor is i2R watts. The loss of energy is i2Rt joules. This loss of energy is converted to heat.

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Chapter 2 : How to measure electrical current, Guide to measuring DC electrical current

By Doug Lowe. Electric current is measured in amperes, but actually in most electronics work, you'll measure current in milliamps, or mA. To measure current, you must connect the two leads of the ammeter in the circuit so that the current flows through the ammeter.

Conductivity electrolytic Electric currents in electrolytes are flows of electrically charged particles ions. Reactions take place at both electrode surfaces, absorbing each ion. Water-ice and certain solid electrolytes called proton conductors contain positive hydrogen ions " protons " that are mobile. In these materials, electric currents are composed of moving protons, as opposed to the moving electrons in metals. In certain electrolyte mixtures, brightly coloured ions are the moving electric charges. The slow progress of the colour makes the current visible. Since the electrical conductivity is low, gases are dielectrics or insulators. However, once the applied electric field approaches the breakdown value, free electrons become sufficiently accelerated by the electric field to create additional free electrons by colliding, and ionizing , neutral gas atoms or molecules in a process called avalanche breakdown. The breakdown process forms a plasma that contains enough mobile electrons and positive ions to make it an electrical conductor. In the process, it forms a light emitting conductive path, such as a spark , arc or lightning. Plasma is the state of matter where some of the electrons in a gas are stripped or "ionized" from their molecules or atoms. A plasma can be formed by high temperature , or by application of a high electric or alternating magnetic field as noted above. Due to their lower mass, the electrons in a plasma accelerate more quickly in response to an electric field than the heavier positive ions, and hence carry the bulk of the current. However, metal electrode surfaces can cause a region of the vacuum to become conductive by injecting free electrons or ions through either field electron emission or thermionic emission. Externally heated electrodes are often used to generate an electron cloud as in the filament or indirectly heated cathode of vacuum tubes. Cold electrodes can also spontaneously produce electron clouds via thermionic emission when small incandescent regions called cathode spots or anode spots are formed. These are incandescent regions of the electrode surface that are created by a localized high current. These regions may be initiated by field electron emission , but are then sustained by localized thermionic emission once a vacuum arc forms. These small electron-emitting regions can form quite rapidly, even explosively, on a metal surface subjected to a high electrical field. Vacuum tubes and sprytrons are some of the electronic switching and amplifying devices based on vacuum conductivity. Superconductivity Superconductivity is a phenomenon of exactly zero electrical resistance and expulsion of magnetic fields occurring in certain materials when cooled below a characteristic critical temperature. Like ferromagnetism and atomic spectral lines , superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect , the complete ejection of magnetic field lines from the interior of the superconductor as it transitions into the superconducting state. The occurrence of the Meissner effect indicates that superconductivity cannot be understood simply as the idealization of perfect conductivity in classical physics. Semiconductor In a semiconductor it is sometimes useful to think of the current as due to the flow of positive " holes " the mobile positive charge carriers that are places where the semiconductor crystal is missing a valence electron. This is the case in a p-type semiconductor. A semiconductor has electrical conductivity intermediate in magnitude between that of a conductor and an insulator. In the classic crystalline semiconductors, electrons can have energies only within certain bands i. Energetically, these bands are located between the energy of the ground state, the state in which electrons are tightly bound to the atomic nuclei of the material, and the free electron energy, the latter describing the energy required for an electron to escape entirely from the material. The energy bands each correspond to a large number of discrete quantum states of the electrons, and most of the states with low energy closer to the nucleus are occupied, up to a particular band called the valence band. Semiconductors and insulators are distinguished from metals because the valence band in any given metal is nearly filled with electrons under usual operating conditions, while very few semiconductor or virtually none insulator of them are available in the conduction band, the band immediately above the valence band. The ease of exciting electrons in the semiconductor from the valence band to the conduction band depends on the band gap between the bands. The size of this energy band gap serves as an arbitrary dividing line roughly 4 eV between semiconductors and insulators. With covalent bonds, an electron moves by hopping to a neighboring bond. The Pauli exclusion principle requires that the electron be lifted into the higher anti-bonding state of that bond. For delocalized states, for example in one dimension â€" that is in a nanowire , for every energy there is a state with electrons flowing in one direction and another state with the electrons flowing in the other. For a net current to flow, more states for one direction than for the other direction must be occupied. For this to occur, energy is required, as in the semiconductor the next higher states lie above the band gap. Often this is stated as: The current-carrying electrons in the conduction band are known as free electrons, though they are often simply called electrons if that is clear in context. Current density Current density is a measure of the density of an electric current. It is defined as a vector whose magnitude is the electric current per cross-sectional area. In SI units , the current density is measured in amperes per square metre.

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Chapter 3 : How is Electricity Measured? | Union of Concerned Scientists

One of the earliest ways to detect electric current was a few wraps of wire around a compass. D'Arsenval extended this idea to make an amperage measurement device (ammeter) by putting a coil inside magnetic poles with bearings and watch escapement springs.

An ampere of current represents the passage of one coulomb of charge per second,â€¦ Electric current in a wire , where the charge carriers are electrons, is a measure of the quantity of charge passing any point of the wire per unit of time. In alternating current the motion of the electric charges is periodically reversed; in direct current it is not. In many contexts the direction of the current in electric circuits is taken as the direction of positive charge flow, the direction opposite to the actual electron drift. When so defined the current is called conventional current. Current is usually denoted by the symbol I. The relationship between current and resistance in an electric circuit. Current in gases and liquids generally consists of a flow of positive ions in one direction together with a flow of negative ions in the opposite direction. To treat the overall effect of the current, its direction is usually taken to be that of the positive charge carrier. A current of negative charge moving in the opposite direction is equivalent to a positive charge of the same magnitude moving in the conventional direction and must be included as a contribution to the total current. Current in semiconductors consists of the motion of holes in the conventional direction and electrons in the opposite direction. Currents of many other kinds exist, such as beams of protons, positrons , or charged pions and muons in particle accelerators. Electric current generates an accompanying magnetic field , as in electromagnets. When an electric current flows in an external magnetic field, it experiences a magnetic force , as in electric motors. The heat loss, or energy dissipated, by electric current in a conductor is proportional to the square of the current. A common unit of electric current is the ampere , a flow of one coulomb of charge per second , or 6. The centimetreâ€”gramâ€”second units of current is the electrostatic unit of charge esu per second. Commercial power lines make available about amps to a typical home; a watt lightbulb pulls about 0. For more on electric current, see electricity: Direct electric current and electricity: Learn More in these related Britannica articles:

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Chapter 4 : electric current | Formula & Definition | calendrierdelascience.com

Electric Current Measurement High accuracy and very high accuracy Current Transducers, Transformers and Instruments for isolated measurement of electric current from 1mA to kA full scale and frequencies from dc to over 2GHz.

Physics for Kids Electric Current Current is the flow of an electric charge. It is an important quantity in electronic circuits. Current flows through a circuit when a voltage is placed across two points of a conductor. Flow of Electrons In an electronic circuit, the current is the flow of electrons. However, generally current is shown in the direction of the positive charges. This is actually in the opposite direction of the movement of the electrons in the circuit. How is current measured? The standard unit of measurement for current is the ampere. It is sometimes abbreviated as A or amps. The symbol used for current is the letter "i". Current is measured as the flow of electric charge over time through a given point in an electric circuit. One ampere is equal to 1 coulomb over 1 second. A coulomb is a standard unit of electric charge. It can also be used to figure out the resistance of a circuit if the voltage is also known or the voltage of a circuit if the resistance is known. AC versus DC There are two main types of current used in most electronic circuits today. They are alternating current AC and direct current DC. Direct Current DC - Direct current is the constant flow of electric charge in one direction. Batteries generate direct current to power handheld items. Most electronics use direct current for internal power often converting alternating current AC to direct current DC using a transformer. Alternating Current AC - Alternating current is current where the flow of electric charge is constantly changing directions. Alternating current is mostly used today to transmit power on power lines. In the United States the frequency at which the current alternates is 60 Hertz. Some other countries use 50 Hertz as the standard frequency. Electromagnetism Current also plays an important role in electromagnetism. This technology is used in electric motors. Interesting Facts about Current The direction of the current flow is often shown with an arrow. In most electronic circuits the current is shown as flowing towards ground. The current in a circuit is measured using a tool called an ammeter. The flowing of electric current through a wire can sometimes be thought of like the flowing of water through a pipe. The electrical conductivity of a material is the measurement of the ability of the material to allow for the flow of electrical current. Activities Take a ten question quiz about this page.

Chapter 5 : What is Electric Current and Theory of Electricity

Electrical Units of Measure The standard units of electrical measurement used for the expression of voltage, current and resistance are the Volt [V], Ampere [A] and Ohm [Î©] respectively.

Current Overview Electric current is the flow of electric charge. The SI unit of electric current is the ampere A , which is equal to a flow of one coulomb of charge per second. Current Fundamentals In solid conductive metal, a large population of electrons is either mobile or free. When a metal wire is connected across the two terminals of a DC voltage source such as a battery, the source places an electric field across the conductor. The moment contact is made, the free electrons of the conductor are forced to drift toward the positive terminal under the influence of this field. The free electron is therefore the current carrier in a typical solid conductor. For an electric current of 1 ampere rate, 1 coulomb of electric charge which consists of about 6. Illustration of Current Flow Conventional current was defined early in the history of electrical science as a flow of positive charge. In solid metals, like wires, the positive charge carriers are immobile, and only the negatively charged electrons flow. Because the electron carries a negative charge, the electron current flows in the opposite direction of the conventional or electric current. When solving electrical circuits, the actual direction of current through a specific circuit element is usually unknown. Consequently, each circuit element is assigned a current variable with an arbitrarily chosen reference direction. When the circuit is solved, the circuit element currents may have positive or negative values. A negative value means that the actual direction of current through that circuit element is opposite that of the chosen reference direction. It is an analog electromechanical transducer that produces a rotary deflection, through a limited arc, in response to electric current flowing through its coil. The coil is attached to a thin pointer that traverses a calibrated scale. A tiny torsion spring pulls the coil and pointer to the zero position. When a direct current DC flows through the coil, the coil generates a magnetic field. This field acts against the permanent magnet. The coil twists, pushing against the spring, and moves the pointer. The hand points at a scale indicating the electric current. Careful design of the pole pieces ensures that the magnetic field is uniform, so that the angular deflection of the pointer is proportional to the current. The mathematical equation that describes this relationship is: However, when the internal resistance is not enough to measure larger currents, an external configuration is needed. To measure larger currents, you can place a precision resistor called a shunt in parallel with the meter. Most of the current flows through the shunt, and only a small fraction flows through the meter. This allows the meter to measure larger currents. Any resistor is acceptable, as long as the maximum expected current multiplied by the resistance does not exceed the input range of the ammeter or data acquisition device. When measuring current in this fashion, you should use the smallest value resistor possible because this creates the smallest interference with the existing circuit. However, smaller resistances create smaller voltage drops, so you must make a compromise between resolution and circuit interference. Figure 2 shows a common schematic of current measurement across a shunt resistor. They do not conform to a transmission standard, and they can range from zero to large values of amperage. Only one current level can be present at any time. The signal is a current loop where 4 mA represents the zero percent signal and 20 mA represents the percent signal. Benefits of the mA convention include wide use by manufacturers, relatively low implementation costs, and its ability to reject many forms of electrical noise. Also, with the live zero, you can directly power low-power instruments from the loop, saving the cost of extra wires. Accuracy Considerations Placement of the shunt resistor in the circuit is important. Figure 3 shows the correct and incorrect placements of the shunt resistor. The NI does not require an external shunt resistor due to the presence of an internal precision resistor. Current Measurement in RSE Configuration In addition to the NI , general-purpose analog input modules, such as the NI , can provide current input functionality using an external shunt resistor. Getting to See Your Measurement:

Chapter 6 : Electrical units of measurment (V,A,Î©,W,)

Electric current is measured in amperes, commonly shortened to "amps." Electric current is the flow rate of charges in a circuit. Electric current is also represented as the ratio of the quantity of charge passing a given point in a circuit to the duration of time the charges were moving.

A current of one ampere is said to flow when one coulomb of charge passes a point in one second. Remember, one coulomb is equal to the charge of 6. Frequently, the ampere is much too large a unit for measuring current. Convert mA to amperes. Some materials offer little opposition to current flow, while others greatly oppose current flow. The standard of measure for one ohm is the resistance provided at zero degrees Celsius by a column of mercury having a cross-sectional area of one square millimeter and a length of A conductor has one ohm of resistance when an applied potential of one volt produces a current of one ampere. The symbol used to represent the ohm is the Greek letter omega W. Resistance, although an electrical property, is determined by the physical structure of a material. The resistance of a material is governed by many of the same factors that control current flow. Therefore, in a subsequent discussion, the factors that affect current flow will be used to assist in the explanation of the factors affecting resistance. What is the symbol for ohm? Test Yourself Factors That Affect Resistance The magnitude of resistance is determined in part by the "number of free electrons " available within the material. Since a decrease in the number of free electrons will decrease the current flow, it can be said that the opposition to current flow resistance is greater in a material with fewer free electrons. Thus, the resistance of a material is determined by the number of free electrons available in a material. A knowledge of the conditions that limit current flow and, therefore, affect resistance can now be used to consider how the type of material, physical dimensions, and temperature will affect the resistance of a conductor. Therefore, the various conductors used in electrical applications have different values of resistance. Consider a simple metallic substance. Most metals are crystalline in structure and consist of atoms that are tightly bound in the lattice network. The atoms of such elements are so close together that the electrons in the outer shell of the atom are associated with one atom as much as with its neighbor. As a result, the force of attachment of an outer electron with an individual atom is practically zero. Depending on the metal, at least one electron, sometimes two, and in a few cases, three electrons per atom exist in this state. In such a case, a relatively small amount of additional electron energy would free the outer electrons from the attraction of the nucleus. At normal room temperature materials of this type have many free electrons and are good conductors. Good conductors will have a low resistance. If the atoms of a material are farther apart, as illustrated in figure view B, the electrons in the outer shells will not be equally attached to several atoms as they orbit the nucleus. They will be attracted by the nucleus of the parent atom only. Therefore, a greater amount of energy is required to free any of these electrons. Materials of this type are poor conductors and therefore have a high resistance. Silver, gold, and aluminum are good conductors. Therefore, materials composed of their atoms would have a low resistance. The element copper is the conductor most widely used throughout electrical applications. Silver has a lower resistance than copper but its cost limits usage to circuits where a high conductivity is demanded. Aluminum, which is considerably lighter than copper, is used as a conductor when weight is a major factor. When would silver be used as a conductor in preference to copper? If the cross-sectional area of a conductor is increased, a greater quantity of electrons are available for movement through the conductor. Therefore, a larger current will flow for a given amount of applied voltage. An increase in current indicates that when the cross-sectional area of a conductor is increased, the resistance must have decreased. If the cross-sectional area of a conductor is decreased, the number of available electrons decreases and, for a given applied voltage, the current through the conductor decreases. A decrease in current flow indicates that when the cross-sectional area of a conductor is decreased, the resistance must have increased. The diameter of conductors used in electronics is often only a fraction of an inch, therefore, the diameter is expressed in mils thousandths of an inch. It is also standard practice to assign the unit circular mil to the cross-sectional area of the conductor. The circular mil is found by squaring the diameter when the diameter is expressed in mils. Thus, if the diameter is 35 mils 0. A comparison between a square mil and a circular mil is illustrated in figure If the length of a conductor is increased, the amount of energy given up increases. As free electrons move from atom to atom some energy is given off as heat. The longer a conductor is, the more energy is lost to heat. The additional energy loss subtracts from the energy being transferred through the conductor, resulting in a decrease in current flow for a given applied voltage. A decrease in current flow indicates an increase in resistance, since voltage was held constant. Therefore, if the length of a conductor is increased, the resistance increases. Which wire has the least resistance? Wire A-copper, circular mils, 6 inches long. Wire B-copper, circular mils, 11 inches long. In some materials an increase in temperature causes an increase in resistance, whereas in others, an increase in temperature causes a decrease in resistance. Most conductors used in electronic applications have a positive temperature coefficient. However, carbon, a frequently used material, is a substance having a negative temperature coefficient. Which temperature coefficient indicates a material whose resistance increases as temperature increases? What term describes a material whose resistance remains relatively constant with changes in temperature?

Chapter 7 : Current Measuring Instruments | Testo, Inc

Volt is the electrical unit of voltage. One volt is the energy of 1 joule that is consumed when electric charge of 1 coulomb flows in the circuit. Ampere is the electrical unit of electrical current. It measures the amount of electrical charge that flows in an electrical circuit per 1 second. Farad.

We provide some of the key guidelines. Current measurements are easy to make, but they are done in a slightly different way to the way in which voltage and other measurements are made. However current measurements often need to be made to find out whether a circuit is operating correctly, or to discover other facts associated with its current consumption. Current measurements can be made with a variety of test instruments, but the most widely used pieces of test equipment for making current measurements is a digital multimeter. These items of test equipment are widely available and at very reasonable prices. Current consists of a flow of electrons around a circuit, and it is necessary to be able to monitor the overall flow of electrons. In very simple circuit is shown below. In this there is a battery, a bulb which can be used as an indicator and a resistor. To change the level of current flowing in the circuit it is possible to change the resistance, and the amount of current flowing can be gauged by the brightness of the bulb. A simple circuit in which to measure current When using a multimeter to measure current, the only way that can be used to detect the level of current flowing is to break into the circuit so that the current passes through the meter. Although this can be difficult at times, it is the best option. A typical current measurement can be made as shown below. From this it can be seen that the circuit in which the current is flowing has to be broken and the multimeter inserted into the circuit. In some circuits where current may often need to be measured, terminals with a shorting link may be added to facilitate the current measurement. How to measure current using a multimeter In order that the multimeter does not alter the operation of the circuit when it is used to measure current, the resistance of the meter must be as low as possible. For measurements of around an amp, the resistance of a meter should be much less than an ohm. For example if a meter had a resistance of one ohm, and a current of one amp was flowing, then it would develop a voltage of one volt across it. For most measurements this would be unacceptably high. Therefore resistances of meters used to measure current are normally very low. How to measure current with an analogue multimeter It is quite easy to use an analogue meter to measure electrical current. There are a few minor differences in way that current measurements are made, but the same basic principles are used. When using the analogue multimeter it is possible to follow a number of simple steps: Insert the probes into the correct connections - this is required because there may be a number of different connections that can be used. Be sure to get the right connections as there may be separate connections for very low or very high current ranges. Set switch to the correct measurement type i. When selecting the range, ensure that the maximum for the particular range chosen is above that anticipated. The range on the multimeter can be reduced later if necessary. However by selecting a range that is too high, it prevents the meter being overloaded and any possible damage to the movement of the meter itself. When taking the reading, optimise the range for the best reading. If possible adjust it so that the maximum deflection of the meter can be gained. In this way the most accurate reading will be gained. Once the reading is complete, it is a wise precaution to place the probes into the voltage measurement sockets and turn the range to maximum voltage position. In this way if the meter is accidentally connected without thought for the range to be used, there is little chance of damage to the meter. This may not be true if it left set for a current reading, and the meter is accidentally connected across a high voltage point! How to measure current with a digital multimeter To measure current with a digital multimeter it is possible to follow a few simple steps: Turn the meter on Insert the probes into the correct connections - in many meters there are a number of different connections for the probes. Often one labelled common into which the black probe is normally placed. The other probe should be entered into the correct socket for the current measurement to be made. Sometimes there is a special connection for current measurements, and sometimes a separate one for either low or high current measurements. Select the correct one for the current measurement to be made. Set main selector switch on the meter switch to the correct measurement type, i. When selecting the range, ensure that the maximum range is above the expected reading anticipated. The range on the DMM can then be reduced as necessary. However by selecting a range that is too high, it prevents the meter being overloaded. When the measuring the current, optimise the range for the best reading. If possible enable all the leading digits to not read zero, and in this way the greatest number of significant digits can be read. Once the reading is complete, it is a wise precaution to place the probes into the voltage measurement sockets and turn the range to maximum voltage. In this way if the meter is accidentally connected without thought for the range used, there is little chance of damage to the meter. Following these steps it is very easy to measure current using any digital multimeter. How to measure ac current with a multimeter It is often necessary to measure AC current. Although the same basic steps are used for taking the AC current measurement as when a normal DC measurement is taken, there are a few additional points to note. The differences in the measurement result from the fact that the multimeter has to rectify the alternating waveform to enable it to measure AC current. For a digital multimeter the main difference is that the measurement type switch must be set to measure AC current rather than DC current.. For an analogue multimeter the situation is a little different. As an analogue multimeter does not contain any active electronics, the diode rectifier used to rectify the alternating waveform has a certain turn on voltage and this will affect the low voltage end of some scales. Some meters may not be able to measure AC current, or they will have very restricted ranges.. Although it is not as common to measure electrical current as it is to measure voltage, it is nevertheless and important ability to be able to measure current. Also knowing how to measure current to gain the best of the multimeter is also important.

Chapter 8 : Electric Current Measurement

Theory of Electricity Current in Metallic Conductor The main cause of current through a metallic substance is the flow of electrons that is the directional drift of free electrons.

Chapter 9 : Ampere - Wikipedia

How to measure current with an analogue multimeter It is quite easy to use an analogue meter to measure electrical current. There are a few minor differences in way that current measurements are made, but the same basic principles are used.