INVERTER THEORY OF OPERATION pdf

1: Basic Theory of DC to AC Inverters - Schematic Design

The term "inverter" also refers to a "rectifier-inverter" group, powered by alternating current and used to vary the voltage and frequency of the output alternating current in function of the input voltage (for example, for power supply of particulars operating machines).

Series and parallel connection to increase our storage system Read How Does an Inverter Work Welcome to this informative page. In this page we are going to explain what an inverter is, what is its function, what it is made of, what its principle of operation and what are the main types of inverters used in the most common situations and needs. Thanks to the help of simple illustrated diagrams, you will be guided in understanding this important electronic device that is indispensable in many fields of application. You will also find the wiring diagram to build a square wave inverter and many practical tips so you can make a safe, conscious and lasting purchase. What is an Inverter and why is it so important? An Inverter is an electronic device capable of transforming a DC DC current into an alternating current AC at a given voltage and frequency. For example, if we have to supply a household appliance that operates in alternating current V 50Hz frequency but we do not have the AC power available, we can still power it by using an inverter such as a 12V DC. It is therefore indispensable to use it to power by DC, electrical devices that work in AC. Inverters are used in stand alone photovoltaic systems for powering electrical devices of isolated houses, mountain huts, camper vans and boats, and are also used in grid-connected photovoltaic systems to enter the current produced by the plant directly into the power grid distribution photovoltaic inverters. The inverters are also used in many other applications, ranging from UPS to the speed controllers of electric motors, from switching power supply to lighting. The term "inverter" also refers to a "rectifier-inverter" group, powered by alternating current and used to vary the voltage and frequency of the output alternating current in function of the input voltage for example, for power supply of particulars operating machines. The most popular inverters used to supply AC power are three types: How does an Inverter work? We said that an inverter can get an alternating current starting from a direct current. To understand this phenomenon it is good to start with the explanation of an alternator. The alternator is a rotating electric machine that transforms mechanical energy into electricity as an alternating current through the natural phenomenon of electromagnetic induction an example is the bicycle dynamo. In its simplest form, it consists of a wire coil with a rotating magnet near it. As soon as a magnet pole approaches the coil, it will create a induced current in the coil and this will flow in the opposite direction to the magnet rotation. An alternating current is then produced. A transformer also produces an alternating current induced in the coil, but this time, the variable magnetic field is produced not by a magnet but by another coil called the primary coil having an alternating current flowing therein. Each coil crossed by an alternating electric current behaves like a magnet and produces a magnetic field. If the direction of the current changes, the polarity of the magnetic field changes. The usefulness of a transformer is that the voltage produced in the secondary coil is not necessarily the same as that applied to the primary coil. If the secondary coil consists of a double winding twice the speed with respect to the primary coil, the secondary voltage will be twice the voltage applied to the primary coil. We can actually produce any voltage we want by varying the size of the coils. If in the primary coil, instead of the alternating current, we run the continuous current of a battery, no induced current is generated in the secondary coil, as the magnetic field does not vary. But if we change direction to current continuously and quickly, then we have already realized a very simple and functional inverter. This inverter outputs a square wave, whose frequency depends on the time when we change the direction of the continuous current circulating in the primary coil. How to make these continuous and rapid changes possible automatically? Below you will find the diagram for making a simple square wave inverter using an astable multivibrator circuit for piloting the primary coil. Of course, this kind of inverter is rich in harmonics and therefore is not suitable for powering neither capacitive nor inductive loads. Only purely resistive loads, such as filament lamps or electric heaters, can be fed. Schematic of a square wave inverter Transistors Q1 and Q2, as well as transformer T1, determine how much power the inverter can deliver. Q1 and Q2 are transistors 2N and T1 is a transformer with maximum current 15A; In this case the inverter can deliver approximately watts.

Remember that if you operate with high currents, this inverter will absorb considerable amounts of current from the battery and in a short time you may find the battery seriously damaged. It is therefore best to set up a sensor to automatically stop the inverter operation as soon as the battery "drops" below a certain voltage threshold. It is also good to insert a protective fuse before the circuit is started up. Sine wave pure inverter To obtain an alternating sinusoidal current at the output of our transformer, we must apply a sinusoidal current at the input. To produce a sinusoidal wave at the input of the primary coil we need an oscillator. The output is stable thanks to feedback. In most oscillating circuits, the output current will be low intensity or in any case not enough to drive the main coil. This current will then need to be amplified from what will be more or less equivalent to a powerful audio amplifier so as to produce a high current for the primary transformer coil. The transformer, though very useful, does nothing at all. As voltage increases, the current decreases, and the power current x voltage remains the same ignoring internal losses to the transformer. In other words, to get 1Kw output in alternating current, we need to supply 1Kw DC input. The best and most expensive inverters are managed by a microcontroller and rely on pulse width modulation PWM. The system can be retracted to provide a stable output voltage at the input input variable. For both types of modulation, the signal quality is determined by the number of bits used. It ranges from a minimum of 3 bits to a maximum of 12 bits, capable of describing the sinusoid with very good approximation.

2: Power Electronics Types of Inverters

Here is the inverter working principle. The inverter is a kind of oscillator. It can produce a high-power AC output from a DC supply, 12V Battery.

This series inverter circuit has the following drawbacks: The maximum possible frequency is limited to the damped frequency of oscillation, i. This is due to the fact that Th1 must be turned off before Th2 is turned on. Otherwise the supply voltage V will be short circuited. When frequency is less than the damped frequency, the distortion of the output voltage waveform is high because Toff is larger in comparison with ON time of thyristor. The circuit components carry load current continuously. The capacitor supplies the load current in every negative half cycle. Thus the current rating of the commutating elements L and C is high. The source supply the load intermittently only during positive half cycle. Therefore source should have a high harmonic content. The maximum load current depends on the load resistance. Therefore, output regulation of the inverter is poor. The drawbacks 1 and 5 can be removed by modifications of the circuit. It has two mutually coupled and exactly similar inductors L1 and L2. This voltage induced across L1 will add to the capacitor voltage in reverse biasing Th2. The circuit conditions and analysis is exactly the same as incase of simple inverter. The advantage in having two inductors is that Th2 can be turned on even before Th1 has turned off. Thus the output frequency can be adjusted to a higher value because time Toff in fig 2 can be eliminated, In fig 1 this action results in short circuit is avoided because of the presence of inductors L1 and L2. Therefore, a voltage equal to capacitor voltage minus the voltage across load will appear across L2 since L1 is mutually coupled with L2 the same voltage will be induced across L1 also, thus the cathode of Th1 will be raised to a higher voltage than the anode and Th1 will be turned off. A similar action will reverse bias Th2 at the end of negative cycle and turn it off. Thus the time interval Toff can be avoided giving a higher output frequency. Fig 4 shows a further improvement in the series inverter. This circuit uses two mutually coupled inductors and two capacitors. In this circuit power is drawn from the source battery during both half cycles. Thus the intermittent operation of battery is avoided. Assume that initial charge across C2 is Ec with polarity as shown. When Th1 is turned on, the load current iL will have two parallel paths. Current i1 will flow from battery, through Th1, L1, load and C2. The current i2 will flow from upper plate of C1, through Th1, L1 and load. Therefore, current i1 and i2 are equal. At the end of positive half cycle the load current iL would be zero and Th1 would be turned off. Voltage across capacitors would be reversed. An exactly similar operation would occur in the negative half cycle. In each half cycle the load current would be supplied by battery and the other half by one of the capacitors. The waveforms are shown in fig 5. Then switch off the dc supply, reduce the inverter frequency and try it again if you do not get the results, check the input fuse and try again.

3: What is the Inverter technology in air conditioners? - Inventor

Inverter is a key system element that is used for power conditioning. Almost any solar systems of any scale include inverter of some type to allow the power to be used on site for AC-powered appliances or on grid.

A close look at the waveform shown shows how the "six-step" power would cause cogging. Current-source inverters are used instead of variable source inverters for large VFDs about horsepower because of their simplicity, regeneration capabilities, reliability and lower cost. Although more rugged and reliable than VSIs, CSIs, have a poor power factor at low speeds, and are not suitable for multi-motor operation. A close examination of the CSIs output voltage waveform shows how this occurs. Pulse width modulated, or PWM VFDs, deliver a constant voltage hertz ratio with no line notching and very stable current input for the motor. The pulse width modulation converter section uses a diode bridge to rectify AC power, rather than an SCR bridge. Since the input to the inverter section is constant, the inverter controls both voltage and frequency. Switching patterns of semiconductors function to convert DC power into AC output. Basically, the main advantages of using pulse width modulation over voltage or current inverters are high efficiency, constant power factor regardless of speed and no cogging problems. Other advantages include wide speed range, open circuit protection and multiple motor operation. The use of a standard motor means the VFD is suitable not only for new applications, but for retro-fitting older existing motors as well. All types of AC speed controls have in common this compatibility with standard motors. In several aspects, VFDs stand in strong contrast to other variable speed controls. The main reasons that VFDs are more desirable than the other types of variable speed controls are: Energy Savings VFDs are by far the most efficient type of speed control, especially when used with centrifugal pumps and fans. When applying a VFD to a centrifugal pump or fan, load characteristics are governed by the "Laws of Affinity. Torque is proportional to the square of the speed change, and horsepower is proportional to the cube of the speed change. When plotting the horsepower curves, it can be seen that as the speed is reduced, the horsepower required at a given speed falls off very rapidly. The horsepower requirement for other types of speed control will also be reduced at reduced speeds, but not as much as the VFD. The difference in the horsepower requirements at a given speed between the VFD and any other type of variable speed control is that VFDs afford greater energy savings. This is one of the basics advantage of the VFD. That is, it will limit the amount of in-rush current. Power companies charge for supplying this in-rush current when starting a motor. This is called a demand charge. Limiting the amount of inrush current on large motors saves money through reducing the demand charge. Improved Process Control One goal of most plants is to automate their processes. The essential aspect of automation is better communication among plant instrumentation devices. Other types of variable speed control are generally limited in, if not completely devoid of, these interface capabilities. Bypass Capability The VFD is very easily bypassed when critical applications require a means of back-up control. Other types of variable speed control are physically coupled with the motor and the load. Whenever a speed control device fails, it must be uncoupled, repaired, and then re-installed. VFDs are bypassed in a matter of seconds whereas other types of speed control, along with their applications, may be down for hours or even weeks. Other types of variable speed control do not afford this possibility. The smaller physical size and lower initial cost of a VFD system are additional advantages. This applies especially to systems of mechanical design, such as eddy current clutch and variable pitch sheaf applications. VFDs help to reduce wear on belts, sheaves, gearboxes, and couplings. All of these ordinarily pose significant maintenance problems, due to wear caused by very caustic or otherwise harsh materials. VFDs do not cycle motors on and off, as is common in other processes. This VFD simply slows the motor and load in order to operate in strict accordance with specifications. By eliminating the cycling process, VFDs function to eradicate troublesome inrush and torque pulsation otherwise present throughout entire operating systems. Variable Frequency Drive Disadvantages 1. Initial Cost The initial cost of the VFD is generally greater than that of other variable speed controls. Initial cost is, in fact, often the primary obstacle for process plants wishing to install a VFD. However, the basic energy savings payback time and process control enhancement with these VFDs more than justifies the investment. Maintenance Skill Set

Objections to the purchase of solid state design equipment generally come from maintenance personnel. Mechanical devices obviously pose no problems, diagnostic or otherwise, for seasoned maintenance workers. A cursory inspection is enough to see whether and why devices fail. VFDs, like any solid state device, require special troubleshooting practical and theory knowledge. VFDs have significantly improved in their diagnostic capabilities. This entails additional and often perennial training for maintenance personnel unfamiliar with solid state design technology. Low Speed Overheating With constant torque applications, there is a possibility that the motor will overheat during low speed operation. This creates a problem at very low speeds, because the VFD reduces motor frequency in order to decrease motor speed. If the motor produces a high level of heat while operating at low speed, overheating results. The lower the continuous operating speed below the motor overheating point, the more the motor and VFD must be derated. This wave-form creates harmonics in the motor. The harmonics are multiples of a fundamental frequency with a current component. The current component will create heat in the motor. The way to overcome this problem is to use a Class F insulation, inverter rated motor. Two aspects of harmonics are distortion and line-notching. Distortion is a result of the non-sinusoidal waveform the VFD generates. This acts to pull the current off of the power line in the form of non-sinusoidal pulses. These can severely distort the power line and if not properly protected, can hinder the operation of other devices on your power line.

4: How Does an Inverter Work: Schematic and Operation

INVERTER SCHOOL TEXT INVERTER BEGINNER COURSE INVERTER SCHOOL TEXT INVERTER BEGINNER COURSE MODEL MODEL CODE Specifications subject to change without notice.

Relays[edit] One way to build an H bridge is to use an array of relays from a relay board. However a semiconductor-based H bridge would be preferable to the relay where a smaller physical size, high speed switching, or low driving voltage or low driving power is needed, or where the wearing out of mechanical parts is undesirable. Another option is to have a DPDT relay to set the direction of current flow and a transistor to enable the current flow. This can extend the relay life, as the relay will be switched while the transistor is off and thereby there is no current flow. It also enables the use of PWM switching to control the current level. A multiple-output flyback converter is well-suited to this application. The transformer core is usually a ferrite toroid, with 1: However, this method can only be used with high frequency signals. The design of the transformer is also very important, as the leakage inductance should be minimized, or cross conduction may occur. Variants[edit] A common variation of this circuit uses just the two transistors on one side of the load, similar to a class AB amplifier. Such a configuration is called a "half bridge". The three-phase inverter is the core of any AC motor drive. A further variation is the half-controlled bridge, where the low-side switching device on one side of the bridge, and the high-side switching device on the opposite side of the bridge, are each replaced with diodes. This eliminates the shoot-through failure mode, and is commonly used to drive variable or switched reluctance machines and actuators where bi-directional current flow is not required. Commercially available[edit] There are many commercially available inexpensive single and dual H-bridge packages, of which the Lx series includes the most common ones. Few packages, like L, [4] have built-in flyback diodes for back EMF protection. Operation as an inverter[edit] A common use of the H bridge is an inverter. The arrangement is sometimes known as a single-phase bridge inverter. The H bridge with a DC supply will generate a square wave voltage waveform across the load. For a purely inductive load, the current waveform would be a triangle wave, with its peak depending on the inductance, switching frequency, and input voltage.

5: "Theory of operation of inverter from scartch" - Entries - Forum - Industry Support - Siemens

q Inverter duty motor construction The Purpose of Induction Motors Contrary to popular belief, induction motors consume very little electrical energy. Instead, they convert electrical energy to mechanical torque (energy). Interestingly enough, the only component more efficient than the motor, in a motor system, is the transformer.

Input voltage[edit] A typical power inverter device or circuit requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The input voltage depends on the design and purpose of the inverter. Hundreds of thousands of volts, where the inverter is part of a high-voltage direct current power transmission system. Output waveform[edit] An inverter can produce a square wave, modified sine wave, pulsed sine wave, pulse width modulated wave PWM or sine wave depending on circuit design. The two dominant commercialized waveform types of inverters as of are modified sine wave and square wave. There are two basic designs for producing household plug-in voltage from a lower-voltage DC source, the first of which uses a switching boost converter to produce a higher-voltage DC and then converts to AC. The second method converts DC to AC at battery level and uses a line-frequency transformer to create the output voltage. Square wave output can produce "humming" when connected to audio equipment and is generally unsuitable for sensitive electronics. Sine wave Sine wave[edit] A power inverter device which produces a multiple step sinusoidal AC waveform is referred to as a sine wave inverter. To more clearly distinguish the inverters with outputs of much less distortion than the modified sine wave three step inverter designs, the manufacturers often use the phrase pure sine wave inverter. Almost all consumer grade inverters that are sold as a "pure sine wave inverter" do not produce a smooth sine wave output at all, [4] just a less choppy output than the square wave two step and modified sine wave three step inverters. However, this is not critical for most electronics as they deal with the output quite well. Where power inverter devices substitute for standard line power, a sine wave output is desirable because many electrical products are engineered to work best with a sine wave AC power source. The standard electric utility provides a sine wave, typically with minor imperfections but sometimes with significant distortion. Sine wave inverters with more than three steps in the wave output are more complex and have significantly higher cost than a modified sine wave, with only three steps, or square wave one step types of the same power handling. AC motors directly operated on non-sinusoidal power may produce extra heat, may have different speed-torque characteristics, or may produce more audible noise than when running on sinusoidal power. Modified sine wave[edit] The modified sine wave output of such an inverter is the sum of two square waves one of which is phase shifted 90 degrees relative to the other. The result is three level waveform with equal intervals of zero volts; peak positive volts; zero volts; peak negative volts and then zero volts. This sequence is repeated. The resultant wave very roughly resembles the shape of a sine wave. Most inexpensive consumer power inverters produce a modified sine wave rather than a pure sine wave. The waveform in commercially available modified-sine-wave inverters resembles a square wave but with a pause during the polarity reversal. Generally, the peak voltage to RMS voltage ratio does not maintain the same relationship as for a sine wave. The DC bus voltage may be actively regulated, or the "on" and "off" times can be modified to maintain the same RMS value output up to the DC bus voltage to compensate for DC bus voltage variations. The ratio of on to off time can be adjusted to vary the RMS voltage while maintaining a constant frequency with a technique called pulse width modulation PWM. The generated gate pulses are given to each switch in accordance with the developed pattern to obtain the desired output. Harmonic spectrum in the output depends on the width of the pulses and the modulation frequency. When operating induction motors, voltage harmonics are usually not of concern; however, harmonic distortion in the current waveform introduces additional heating and can produce pulsating torques. Items with a switch-mode power supply operate almost entirely without problems, but if the item has a mains transformer, this can overheat depending on how marginally it is rated. However, the load may operate less efficiently owing to the harmonics associated with a modified sine wave and produce a humming noise during operation. Therefore, pure sine wave inverters may provide significantly higher efficiency than modified sine wave inverters. However, they may be quite noisy. A series

LC filter tuned to the fundamental frequency may help. This signal then goes through step-up transformers generally many smaller transformers are placed in parallel to reduce the overall size of the inverter to produce a higher voltage signal. The output of the step-up transformers then gets filtered by capacitors to produce a high voltage DC supply. Output frequency[edit] The AC output frequency of a power inverter device is usually the same as standard power line frequency, 50 or 60 hertz If the output of the device or circuit is to be further conditioned for example stepped up then the frequency may be much higher for good transformer efficiency. Output voltage[edit] The AC output voltage of a power inverter is often regulated to be the same as the grid line voltage, typically or VAC at the distribution level, even when there are changes in the load that the inverter is driving. This allows the inverter to power numerous devices designed for standard line power. Some inverters also allow selectable or continuously variable output voltages. Output power[edit] A power inverter will often have an overall power rating expressed in watts or kilowatts. This describes the power that will be available to the device the inverter is driving and, indirectly, the power that will be needed from the DC source. Smaller popular consumer and commercial devices designed to mimic line power typically range from to watts. Not all inverter applications are solely or primarily concerned with power delivery; in some cases the frequency and or waveform properties are used by the follow-on circuit or device. Batteries[edit] The runtime of an inverter powered by batteries is dependent on the battery power and the amount of power being drawn from the inverter at a given time. As the amount of equipment using the inverter increases, the runtime will decrease. In order to prolong the runtime of an inverter, additional batteries can be added to the inverter. Series configuration If the goal is to increase the overall voltage of the inverter, one can daisy chain batteries in a series configuration. In a series configuration, if a single battery dies, the other batteries will not be able to power the load. Parallel configuration If the goal is to increase capacity and prolong the runtime of the inverter, batteries can be connected in parallel. This increases the overall ampere-hour Ah rating of the battery set. If a single battery is discharged though, the other batteries will then discharge through it. This can lead to rapid discharge of the entire pack, or even an over-current and possible fire. To avoid this, large paralleled batteries may be connected via diodes or intelligent monitoring with automatic switching to isolate an under-voltage battery from the others. The unit shown provides up to 1. An inverter converts the DC electricity from sources such as batteries or fuel cells to AC electricity. The electricity can be at any required voltage; in particular it can operate AC equipment designed for mains operation, or rectified to produce DC at any desired voltage. Uninterruptible power supplies[edit] An uninterruptible power supply UPS uses batteries and an inverter to supply AC power when mains power is not available. When mains power is restored, a rectifier supplies DC power to recharge the batteries. Electric motor speed control[edit] Inverter circuits designed to produce a variable output voltage range are often used within motor speed controllers. The DC power for the inverter section can be derived from a normal AC wall outlet or some other source. Control and feedback circuitry is used to adjust the final output of the inverter section which will ultimately determine the speed of the motor operating under its mechanical load. Motor speed control needs are numerous and include things like: The generated gate pulses are given to each switch in accordance with the developed pattern and thus the output is obtained. In refrigeration compressors[edit] An inverter can be used to control the speed of the compressor motor to drive variable refrigerant flow in a refrigeration or air conditioning system to regulate system performance. Such installations are known as inverter compressors. Traditional methods of refrigeration regulation use single-speed compressors switched on and off periodically; inverter-equipped systems have a variable-frequency drive that control the speed of the motor and thus the compressor and cooling output. The variable-frequency AC from the inverter drives a brushless or induction motor , the speed of which is proportional to the frequency of the AC it is fed, so the compressor can be run at variable speedsâ€”eliminating compressor stop-start cycles increases efficiency. A microcontroller typically monitors the temperature in the space to be cooled, and adjusts the speed of the compressor to maintain the desired temperature. The additional electronics and system hardware add cost to the equipment, but can result in substantial savings in operating costs. They also need a means of detecting the presence of utility power for safety reasons, so as not to continue to dangerously feed power to the grid during a power outage. Synchronverters are inverters that are designed to simulate a rotating generator, and can be used to help stabilize grids. They can be designed to react faster than normal generators to changes in grid frequency, and can give conventional generators a chance to respond to very sudden changes in demand or production. Solar[edit] Internal view of a solar inverter. Note the many large capacitors blue cylinders , used to store energy briefly and improve the output waveform. Solar inverter A solar inverter is a balance of system BOS component of a photovoltaic system and can be used for both grid-connected and off-grid systems. Solar inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection. Solar micro-inverters differ from conventional inverters, as an individual micro-inverter is attached to each solar panel. This can improve the overall efficiency of the system. The output from several micro-inverters is then combined and often fed to the electrical grid. Induction heating[edit] Inverters convert low frequency main AC power to higher frequency for use in induction heating. To do this, AC power is first rectified to provide DC power. The inverter then changes the DC power to high frequency AC power. Due to the reduction in the number of DC sources employed, the structure becomes more reliable and the output voltage has higher resolution due to an increase in the number of steps so that the reference sinusoidal voltage can be better achieved. This configuration has recently become very popular in AC power supply and adjustable speed drive applications. This new inverter can avoid extra clamping diodes or voltage balancing capacitors. There are three kinds of level shifted modulation techniques, namely: At the receiving location, an inverter in a static inverter plant converts the power back to AC. The inverter must be synchronized with grid frequency and phase and minimize harmonic generation. First the 9 V DC is converted to â€" V AC with a compact high frequency transformer, which is then rectified and temporarily stored in a high voltage capacitor until a pre-set threshold voltage is reached. When the threshold set by way of an airgap or TRIAC is reached, the capacitor dumps its entire load into a pulse transformer which then steps it up to its final output voltage of 20â€"60 kV. A variant of the principle is also used in electronic flash and bug zappers , though they rely on a capacitor-based voltage multiplier to achieve their high voltage. Miscellaneous[edit] Typical applications for power inverters include: Portable consumer devices that allow the user to connect a battery , or set of batteries, to the device to produce AC power to run various electrical items such as lights, televisions, kitchen appliances, and power tools. Use in power generation systems such as electric utility companies or solar generating systems to convert DC power to AC power. Use within any larger electronic system where an engineering need exists for deriving an AC source from a DC source. Circuit description[edit] Top: Simple inverter circuit shown with an electromechanical switch and automatic equivalent auto-switching device implemented with two transistors and split winding auto-transformer in place of the mechanical switch. Square waveform with fundamental sine wave component, 3rd harmonic and 5th harmonic Basic design[edit] In one simple inverter circuit, DC power is connected to a transformer through the center tap of the primary winding. A switch is rapidly switched back and forth to allow current to flow back to the DC source following two alternate paths through one end of the primary winding and then the other.

INVERTER THEORY OF OPERATION pdf

6: Working Principle of a Solar Inverter | Solar Inverter Guide

Inverters are used in PV systems to produce AC power from a DC source, such as a PV array or batteries. Inverter sizes range f\àµ²om module-level inverters rated a few hundred watts to utility-scale inverters 1 MW and larger.\çˆ€å±²Reference: Photovoltaic Systeå°•ms, Chap. 8\.

Print Inverter is a key system element that is used for power conditioning. Almost any solar systems of any scale include inverter of some type to allow the power to be used on site for AC-powered appliances or on grid. Different types of inverters are shown in Figure On the utility scale, the main challenges are related to system configuration in order to achieve safe operation and to reduce conversion losses to a minimum. Those wave types were briefly introduced in Lesson 6 Figure Here, we will take a closer look at the physical principles used by inverters to produce those signals. Different types of AC signal produced by inverters. Mark Fedkin The process of conversion of the DC current into AC current is based on the phenomenon of electromagnetic induction. Electromagnetic induction is the generation of electric potential difference in a conductor when it is exposed to varying magnetic field. For example, if you place a coil spool of wire near a rotating magnet, electric current will be induced in the coil Figure Schematic illustration of electromagnetic induction Credit: Mark Fedkin Next, if we consider a system with two coils Figure If the direction of the current is reversed frequently e. During the 1st half cycle top , DC current from a DC source - solar module or battery - is switched on through the top part of the primary coil. During the 2nd half cycle bottom , the DC current is switched on through the bottom part of the coil. Mark Fedkin The simple two-cycle scheme shown in Figure This is the simplest case, and if the inverter performs only this step, it is a square-wave inverter. This type of output is not very efficient and can be even detrimental to some loads. So, the square wave can be modified further using more sophisticated inverters to produce a modified square wave or sine wave Dunlop, To produce a modified square wave output, such as one shown in the center of Figure This feature allows adjusting the duration of the alternating square pulses. Also, transformers are used here to vary the output voltage. Combination of pulses of different length and voltage results in multi-stepped modified square wave, which closely matches the sine wave shape. To produce a sine wave output, high-frequency inverters are used. These inverters use the pulse-width modification method: For example, very narrow short pulses simulate a low voltage situation, and wide long pulses simulate high voltage. Also, this method allows spacing the pulses to be varied: Pulse-width modulation to approximate the true sine wave by high frequency inverter. Mark Fedkin modified after Dunlop, In the image above, the blue line shows the square wave varied by the length of the pulse and timing between pulses; the red curve shows how those alternating signals are modeled by a sine wave. Using very high frequency helps create very gradual changes in pulse width and thus models a true sine signal. The pulse-width modulation method and novel digital controllers have resulted in very efficient inverters Dunlop, Utility Solar Power and Concentration Search form.

7: Simple inverter working principle | www.enganchecubano.com

Road testing a plug and play w grid tie www.enganchecubano.comons arise? What is modified sine wave/pure sign wave and can these inexpensive inverters connect to your battery banks.

The AC drives are now commonly applied to air handlers, pumps, chillers and tower fans. A better understanding of AC drives will lead to improved application and selection of both equipment and HVAC systems. This article is intended to provide a basic understanding of AC drive operation principle and theory, and AC drive benefits. AC Drive Operation Understanding the basic principles and theory behind AC drive operation requires understanding the three basic sections of the AC drive: The voltage on an alternating current ac power supply rises and falls in the pattern of a sine wave see Figure 1. When the voltage is positive, current flows in one direction; when the voltage is negative, the current flows in the opposite direction. This type of power system enables large amounts of energy to be efficiently transmitted over great distances. The rectifier in an AC drive is used to convert incoming ac power into direct current dc power. One rectifier will allow power to pass through only when the voltage is positive. A second rectifier will allow power to pass through only when the voltage is negative. Two rectifiers are required for each phase of power. Since most large power supplies are three phase, there will be a minimum of 6 rectifiers used see Figure 2. Appropriately, the term "6 pulse" is used to describe a variable frequency drive with 6 rectifiers. An AC drive may have multiple rectifier sections, with 6 rectifiers per section, enabling an AC drive to be "12 pulse," "18 pulse," or "24 pulse. Existing technology Rectifiers may utilize diodes, silicon controlled rectifiers SCR , or transistors to rectify power. Diodes are the simplest device and allow power to flow any time voltage is of the proper polarity. Silicon controlled rectifiers include a gate circuit that enables a microprocessor to control when the power may begin to flow, making this type of rectifier useful for solid-state starters as well. Transistors include a gate circuit that enables a microprocessor to open or close at any time, making the transistor the most useful device of the three. An AC drive using transistors in the rectifier section is said to have an "active front end. The dc bus contains capacitors to accept power from the rectifier, store it, and later deliver that power through the inverter section. The dc bus may also contain inductors, dc links, chokes, or similar items that add inductance, thereby smoothing the incoming power supply to the dc bus. The final section of the AC drive is referred to as an inverter. The inverter contains transistors that deliver power to the motor. The IGBT can switch on and off several thousand times per second and precisely control the power delivered to the motor. Motor speed rpm is dependent upon frequency. Varying the frequency output of the AC drive controls motor speed: AC drives provide the following basic advantages: The remaining hours of operation need only a fraction of the flow. Traditionally, devices that throttle output have been employed to reduce the flow. However, when compared with speed control, these methods are significantly less efficient. Mechanical Capacity Control Throttling valves, vanes, or dampers may be employed to control capacity of a constant speed pump or fan. These devices increase the head, thereby forcing the fan or pump to ride the curve to a point where it produces less flow Figure 3. Power consumption is the product of head and flow. Throttling the output increases head, but reduces flow, and provides some energy savings. Mechanical capacity control Variable Speed Capacity Control For centrifugal pumps, fans and compressors, the ideal fan affinity laws describe how speed affects flow, head and power consumption Table A. When using speed to reduce capacity, both the head and flow are reduced, maximizing the energy savings. A basic comparison of mechanical and speed control for capacity reduction Figure 4 shows that variable speed is the most efficient means of capacity control. Comparison of mechanical capacity control and speed capacity control Low Inrush Motor Starting Motor manufacturers face difficult design choices. Designs optimized for low starting current often sacrifice efficiency, power factor, size, and cost. With these considerations in mind, it is common for AC induction motors to draw 6 to 8 times their full load amps when they are started across the line. When large amounts of current are drawn on the transformers, a voltage drop can occur, adversely affecting other equipment on the same electrical system. Some voltage sensitive applications may even trip off line. For this reason, many engineers specify a means of reducing the starting current of large AC induction motors. Soft Starters

Wye-delta, part winding, autotransformer, and solidstate starters are often used to reduce inrush during motor starting. All of these starters deliver power to the motor at a constant frequency and therefore must limit the current by controlling the voltage supplied to the motor. Wye delta, part winding, and autotransformer starters use special electrical connections to reduce the voltage. Solid-state starters use SCRs to reduce the voltage. The amount of voltage reduction possible is limited because the motor needs enough voltage to generate torque to accelerate. With maximum allowable voltage reduction, the motor will still draw two to four times the full load amps FLA during starting. Additionally, rapid acceleration associated with wye-delta starters can wear belts and other power transmission components. AC drives as Starters An AC drive is the ideal soft starter since it provides the lowest inrush of any starter type as shown in Table B. Unlike all other types of starters, the AC drive can use frequency to limit the power and current delivered to the motor. The AC drive will start the motor by delivering power at a low frequency. At this low frequency, the motor does not require a high level of current. The AC drive incrementally increases the frequency and motor speed until the desired speed is met. The current level of the motor never exceeds the full load amp rating of the motor at any time during its start or operation. In addition to the benefit of low starting current, motor designs can now be optimized for high efficiency.

8: DC Inverter Air Conditioner Working Principles

Title: "The ABC's of DC to AC Inverters", arranged "by Electronic's Department of Northen Alberta Institure of Technology. This document will show you the basic theory of DC to AC inverters, about the circuit's works, the calculation to build DC to AC inverter and more.

The 12V from the positive terminal of the battery comes to the center tap CT of 12V winding. Now it is the primary coil. The two ends of the coil A and B point are connected to the 2 ways switch to the ground. First, if the switch connects to A point. The current number 1 flows from the battery into CT through A contact of the switch to the ground. Second, if you turn the switch from A into B. It causes the current number 1 to stops flowing. Then, the current 2 flows to the ground through CT and contact B of the switch. Third, this 2 ways switch is controlled with the square wave oscillator. It causes the switch to selects between A and B point with speed about 50 times per second. Also, the current 1 and 2 flow to the transformer alternately at a rate of 50 times per second. Now, the current flows into the transformer alternately look like AC voltage. According to the theory of transformers. The electromagnetic field swells and collapses. And then, a current will be inducted into the secondary, V winding. Which it causes AC voltage V 50Hz. The voltage is ready to be supplied to the various types of electrical equipment that require AC Volt in operation. But the output current always decreased to lower levels. If you want to take the inverter to 10W load. The current of transformer should be at least of about 1A.

INVERTER THEORY OF OPERATION pdf

9: The CMOS Inverter Explained

The inverters work by taking in power from a Direct Current (DC) Source, i.e., the solar panel. The power is generated in the range of Volts to Volts. DC power is converted into AC power by the inversion process taking place in the inverter.

Before we begin our analysis it is important to mention three items. The MOSFETS must be perfectly matched for optimum operation, that is, they must have the same threshold voltage magnitude and conduction parameter. In this case when we apply an input voltage between 0 and VTN. The PMOS device on since a low voltage is being applied to it. The NMOS is already negative enough and has no use for more free electrons so it refuses to conduct and turns into a large resistor. Since the NMOS device is on vacation, there is no current flow through either device. The power dissipation is zero. We find that the PMOS device remains in the linear region since it still has adequate forward bias. Current now flows through both devices. Power dissipation is no longer zero. The maximum allowable input voltage at the low logic state VIL occurs in this region. We label this point VM and identify it as the gate threshold voltage. For a very short time, both devices see enough forward bias voltage to drive them to saturation. This, in turn, drives the PMOS into saturation. This region is effectively the reverse of region II. The minimum allowable input voltage at the logic high state VIH occurs in this region. The PMOS is out to lunch since it is seeing a positive drive but it is already positive enough and has no use for more. The total power dissipation is zero just as in region I. Power dissipation only occurs during switching and is very low. Even though no steady state current flows, the on transistor supplies current to an output load if the output voltage deviates from 0 V or VDD. This makes CMOS technology useable in low power and high-density applications. Try changing some of the transistor parameters such as W, L, and KP.

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