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Design and Development of SCR Firing Circuit for MPI Current Source

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ABSTRACT: In boiler industry tube form major portions of the steam generation system. Thousands of welding joints are made by automatically and semi-automatically welding machines. In weld mends different types of weld flaws occur. This range from porosity to serious defects such as cracks and lack of fusion. Real time system using high current source equipment was installed at BHEL TRICHY for NDTL inspection of welded particles, boilers and pipes. For this purpose MPI current source are used in NDTL Inspection we designed the control panel for that machine configured by BHEL R & D where interfaced with existing system at BHEL.

I. INTRODUCTION

Magnetic particle inspection (MPI) is a non destructive testing method used for detect detection. MPI is fast and relatively easy to apply, and part surface preparation is not critical as it is for some other NDT method. These characteristics make MPI one of the most widely utilized non destructive testing methods.

MPI uses magnetic field and small magnetic particle (i.e. Iron filing) to detect flaws in components. The only requirement from an inspectability standpoint is that the component being inspected must be made of a ferromagnetic material such as iron, nickel, cobalt ,or some of their alloys. Ferromagnetic materials are the materials that can be magnetized to a level that will allow the inspection to be effective.

The method is used to inspect a variety of products forms including castings, forgings, and weldments. Many different industries use magnetic particle inspection for determining a component's fitness-for-use. Space some examples of indrutries that use magnetic particle inspection are the structural steel, automotive, petrochemical, power generation, and aerospace industries. Underwater inspection is another area where magnetic particle inspection may be used to test items such as offshore structures and underwater pipelines.

A. BASIC PRINCIPLES

In theory, magnetic particle inspection (MPI) is a relatively simple concept. It can be considered as a combination of two non- destructive testing method: Magnetic flux leakage testing and visual testing. Consider the case of a bar magnet. It has a magnetic field in and around the magnet. Any place that a magnetic line of force exits or enters the magnet is called pole. A pole where a magnetic line of force exits the magnet called a north pole and a pole where a line of force enters the magnet is called a south magnet.

When a bar magnet is broken is the center of its length, two complete bar magnets with magnetic poles on each end of each piece will result. If the magnet is just cracked but not broken completely in two, a north and south pole will form at each edge of the crack. The magnetic field exits the North Pole and re-enters at the South Pole. The magnetic field spreads out when it encounters the small air gap created by the crack because the air cannot support as much magnetic field per unit volume as magnet can. When the field spreads out, it appears to leak out of the material and this is called a flux leakage field.

If iron particles are sprinkled on a cracked magnet, the particles will be attracted to and cluster not only at the poles at the ends of the magnet, but also at the poles at the edges of the crack. This cluster of particles is much easier to see then the actual crack and this is the basic for magnetic particle inspection.

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The first step in a magnetic particle inspection is to magnetize the component that is to be inspected. If any defects on or near the surface are present, the defects will create a leakage field. After the component has been magnetized ,iron particles, either in a dry or wet suspended form, are applied to the surface of the magnetized part. The particles will be attracted and cluster at the flux leakage fields, thus forming a visible indication that the inspector can detect.

B. PORTABLE MAGNETIZING EQUIPMENT FOR MPI

To properly inspect a part for cracks or other defects, it is important to become familiar with the different types of magnetic fields and the equipment used to generate them.as discussed previously, one of the primary requirements for detecting a defect in a ferromagnetic material is that the magnetic field induced in the part must intercept the defect at 45 to 90 degree angle. Flaws that are normal (90degree) to the magnetic field will produce the strongest indications because they disrupt more of the magnet flux. Therefore, for proper inspection of a component, it is important to be able to establish a magnetic field in at least two directions. A variety of equipment exists to establish the magnetic field for mpi.one way to classify equipment is based on its portability. Some equipment is designed to be portable so that inspections can be made in the field and some is designed to be stationary for ease of inspection in the laboratory or manufacturing facility. Portable equipment will be discussed first.

C. ELECTROMAGNET

Today most of the equipment used the magnetic field used in mpi is based on electromagnetism. That is, using an electrical current to produce the magnetic field. An electromagnetic yoke is a very common piece of equipment that is used to establish a magnetic field. It is basically made by wrapping an electrical coil around a piece of soft ferromagnetic steel. A switch is included in the electrical circuit so that the current and therefore, the magnetic field can be turn on and off. They can be powered with alternating current from a wall socket or by direct current from a battery pack. This type of magnet generates a very strong magnetic field in a local area where the poles of the magnet touch the part being inspected. Some yokes can lift weights in excess of 40 pounds.

D. MAGNETIC PARTICLES:

As mentioned previously, the particles that are used for magnetic particle inspection are a key ingredient as they from the indications that alert the inspector to defects. Particle starts out as tiny milled (a machining process) pieces of iron or iron oxide. A pigment (somewhat like paint) is bounded to their surfaces to give the particles color. The metal used for the particle has high magnetic permeability and low retentivity. High magnetic permeability is important because it makes the particle attract easily to small magnetic leakage fields from discontinuities, such as flaws. Low retentivity is important because the particle themselves never become strongly magnetized so they do not stick each other or the surface of the part. Particles are available in a dry mix or a wet solution.

E. SUSPENSION LIQUIDS:

Suspension liquids used in the wet magnetic particle inspection method can be either a well refined light petroleum distillate or water containing additives.

Petroleum based liquids are the most desirable carriers because provided good wetting of the surface of metallic parts. However, water based carriers are used more because of low cost, low fire hazard, and the ability to form indications quicker than solvent based carriers. Water based carriers must contain wetting agents to disrupt surface films of oil that may exists on the part and to aid in the dispersion of magnetic particles in the carrier. The wetting agents create foaming as the solution is moved about, so anti foaming agents must be added. Also, since water promotes correction in ferrous materials, corrosion inhibitors are usually added as well.

Petroleum based carriers are primarily used in systems where maintaining the proper particle concentration is a concern.the petroleum based carriers require less maintenance because they evaporate at a slower rate than the water based carriers.therefore petroleum based carriers might might be better choice for a system that gets only occasional use or when regularly adjusting the carrier volumn is undesirable.modern solvent carriers are specifically designed with properties that have flash points above 200oF and keep nocuous vapours low.

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II. OBJECTIVE

The main of our project is to find crack in welded particles by passing high current of 10000A.MPI stands for Magnetic Particle Inspection.

It is a non - destructive testing method. When a high current is passed over the test object, magnetic field is formed in the material, if there is any discontinuity in the surface means the magnetic flux starts to leak. Since air cannot passed to the material, ferrous iron particle is sprayed over them. The particle may be dry or wet suspension. If there is any crack means these particle will get attracted over them

III. LITERATURE REVIEW

A critical review of the available literature concerning the minimum reliably detectable defect size aNDI for Magnetic Particle Testing (MPT) in aerospace applications is presented. Four Probability Of Detection (POD) studies relevant to detection of fatigue cracks in aircraft components were found over the period 1968 to 2011.as the statistical method used in these four previous studies were either outdated or otherwise deficient, the original data were reanalyzed using currently accepted techniques. A meta-analysis of the results is presented, with emphasis on statistical inferences for the defect size expected to be detected with 90% pod.it is shown that the minimum reliably detectable defect size aNDI=2.0mm currently specified by the royal Australian air force for wet fluorescent magnetic particle inspection using the continuous method is consistent with estimates of the average performance of MPI derived from the reanalyzed of the literature.

In the damage-tolerance approach to airworthiness, fatigue-critical aircraft structure is subject to regular non-destructive inspection (NDI) to prevent catastrophic structural failure. Periodic inspection intervals are determined using knowledge of the minimum crack size that can be reliably detected, together with information on the structural loads, critical defect size and critical growth rates. The minimum reliably detectable crack size, aNDI is determined through analysis of the portability of detection (POD) of defects as a function of defect size. Quantitative measurement of aNDI for a given NDI procedure is arguably as challenging to obtain as the other key input to damage-tolerance analyses.

The defence size and technology organization (DSTO) is conducting a serial of critical literature reviews to examine the reliability of standard non-destructive inspection methods used for Australian defence force (ADF) aircraft. The first review (dsto-tr_2623) examined the reliability of liquid penetrant testing (lpt). The present report is the second in the series and is concerned with magnetic particle testing (mpt).mpt is a technically mature inspection method used to detect surface-breaking cracks in high strength steel components.

a survey of the available literature on the reliability of MPI found some twenty reverences relevant to pod over the period 1968-2011.after critical review, four published studies were considered applicable to detection of fatigue cracks in the high strength steel aerospace components.it was found that the original statistical analysis methods used in this four studies were either outdated or deficient in the other aspects. Thus, the original pod data were reanalyzed using the currently accepted approach in which maximum likelihood estimation was used to fit a log-normal cumulative distribution function to the pod hit/miss data as a function of crack size and statistical confidence levels were determined using the Q2 likelihood ratio statistic. The data apply to wet fluorescent particle inspection using the continuous magnetization method.

Analysis of the MPT POD studies showed a spread in performance between organizations involved in the various trials. Following a meta- analysis, it was concluded that the aNDI=2.0mm currently assumed by the royal Australian air force is consistent with the average performance of MPT derived from the relevant available literature. The smallest aNDI consistent with most implementations of MPT is 2.6mm. On this basis, the results do not support a reduction in the standard limitation for MPI

IV. MODELLING OF MPI

A. BASIC BLOCK DIAGRAM:

The basic block diagram of magnetic particle inspection consists of the control PCB, SCR and other components. Power supply is given to the SCR and control PCB where the firing angles of SCR is controlled. SCR varies the primary voltage of the transformer correspondingly secondary voltage is produced. Output voltage from the transformer is given to the bridge rectifier then the rectified dc is applied to the testing coil for crack detection.

a. DIFFERENT TYPES OF MPI DETECTORS:

b. PORTABLE CRACK DETECTORS:

MAGNO-MASTER 1500 has been specially designed for use as a portable unit. It is normally supplied for table mounting and can be lifted by handle by one man. The accessories are contained in a sturdy canvas bag. A special box type trolley with locking arrangement for accessories is available as an optional accessory. A pram type trolley for easy maneuverability is also available. The equipment is suitable for detecting all surface and sub-surface cracks up to a depth of 6mm in Ferro-magnetic objects of any shape and size. Demagnetization is achieved by the suitable diameter. Facility for remote control operation has been provided.

Weighing 42kg without accessories and having output up to a max of 1000 amp AC and half wave DC for surface and sub-surface detection up to a depth of 6mm in ferrous components of varied types of shapes and sizes and in welds.

c. MOBILE TYPE CRACK DETECTORS:

Magno-van-2500 WG has been specially designed for use as a mobile unit. It is mounted on a wagon with two sturdy rubber wheels and a V rest. The equipment is easily pushed around and maneuvered into desired position by one person. The equipment is suitable for detecting all surface cracks and sub-surface cracks up to a depth of 6mm in ferromagnetic objects of any shape and size. Demagnetization is achieved by coil or prod method. Facility for remote control operation has been provided. Mobile units with outputs up to 6000 amps are in our regular line of production.

Various models in the range of 2000 to 6000 amps AC and half wave DC in our regular line of production.

d. COIL TYPE CRACK DETECTORS:

MCD 25-7-5 CF 10:

Stationary unit of contact and coil type in the medium range output of 2500 amp in 6 steps for longitudinal magnetization. Suitable for detection of surface and near surface cracks in Ferro-magnetic components up to 1000mm long, 80mm diameter and 50k weight. Facility for combined magnetization by simultaneous application for circulation and longitudinal fields provided. Dark room an integral part of the unit. Demagnetization by separate demagnetizer. HWDC facility for detection of sub surface cracks and inclusions provided optionally.

Power: 415v-3ph-HZ-60Amps intermittent

Various models in the range of 1000-6000Amps for circular mag and up to in our 15000 Ampere turns for long mag with clamping distance from the smallest to 4.5mtr.

e. YOKE TYPE CRACK DETECTORS:

MCD 25-15 YF 06

Stationary unit of contact and yoke type in the medium range. Output of 2500 Amps AC in 6 steps for circular magnetization and 15 kilo Ampere turns DC in 6steps for longitudinal magnetization. Suitable for detection of surface and near surface cracks in ferromagnetic components up to 600mm long.80 mm diameter and 50kg weight. Facility for combined magnetization by simultaneous application of circular and longitudinal fields provided. Dark room an integral part of the unit. Demagnetization by separate demagnetizer. HWDC facility for detection of sub surface cracks and inclusions provided optionally.

Power: 415v-3ph-HZ-60Amps intermittent

Various models in the range of 1000-6000Amps for circular mag and up to in our 15000 Ampere turns for long mag with clamping distance from the smallest to 4.5mtr.

f. Demagnetizers:

Table mounting type:

The demagnetizer comprises of a coil through which AC at mains frequency is passed. The job to be demagnetized is pulled out of the coil. Along its longitudinal axis and kept at a distance beyond 1mtr from the coil. Two versions of the coil DM 200 and DM 300 with round port of 200 and 300mm respectively are in our current line of production, for safety MCB provided. The coil work of 230V AC, 50 cycle, Single phase supply and give very satisfactory results.

B. TRACK AND CARRIAGE TYPE:

This type of demagnetizer comprises of a square coil mounted on a steel frame with track and carriage. The job to be demagnetized is placed on the carriage along the longitudinal axis loading end. Current is switched on by pressing a push button and the carriage pushed out of the coil portal to the other end. The current cuts off automatically at the termination of the time set on the electronic timer. Several versions of this type of demagnetizer with coil port in the range of 300 to 600 mm square port are in our regular line of production.

Round shaped coils of 200 and 300mm diameter and square shaped coils in the range of 300 to 800 mm port wit track and carriage.

C. BAR TESTING MACHINE

MCD -350CF:

This SPM is with spring grip facility and used for testing surface as well as sub surface defects or cracks in bar. This machine is also available with coil type for longitudinal magnetization for checking circular cracks and circular magnetization for longitudinal cracks. This is provided with spring grips where compressed air is not available.

a. Power supply required:

415V 3ph 50HZ AC 63 Amps

Various models both automatic and semi-automatic for checking of bars of various diameters and lengths.

MCD-5000WOGAN:

this SPM is basically used for testing surface as well as subsurface cracks of bars up to diameter of 150mtr amps of far above capacity of machine varies. This is a mobile type of unit and use far many other purpose by selection of current.

Power supply required: 415V 3ph 50HZ AC 100Amps

Compressed air: 5kg/q.cm

Various models both automatic and semi-automatic for checking of bars of various diameters and lengths.

b. INLINE CRACK DETECTION:

MCD 35-05-CF-SPM:

A special purpose machine designed for detection of all surface and surface and sub-surface cracks. This machine is specially designed for in line crack detection. In this finished or semi-finished products are kept on indexing table and automatically get magnetized one by one. After cycle start operation through PLC control. Two types of mag is provided. CIR as well as longitudinal and also COMB facility and auto/manual mode provided.

Power required:

415V AC 3ph 63 Amps

Compressed air: 5kg/ sq.cm

This bar testing machine is used for testing surface and subsurface cracks in bar as well as fasters and many small components of bars. This machine consists of two types of defect testing with circular magnetization and longitudinal magnetization. Can be made available with combination magnetization.

MAGNETIC POWDERS:

WET: fluorescent, non fluorescent, Red and Black

DRY: Red and Black.

Applicable standards and powders free along with equipment.

CRACK DETECION LIMITS: surface, near surface, sub surface up to 2.5mm depth. With prod method 6mm sub surface.

DEMAGNETISATION: clamp the coil at the job position and fix the H.C cable output at AC mode and with draw the jobs from coil portal by pressing foot switch.

Manufacturing standard as per A S T M, BS , DIN, JIS.

D. TRANSFORMERS:

A transformer is based on a simple fact about electricity. When a fluctuating electric current flows through a wire, it generates a magnetic field (an invisible pattern of magnetism) or “magnetic flux” all around it. The strength of magnetism (which has the rather technical name of magnetic flux density) is directly related to the electric current. The larger amount of current, the stronger the magnetic field. When a magnetic field fluctuates around a piece of wire, it

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generates an electric current in the wire. So if we put a second coil of wire next to the first one, and send a fluctuating electric current into the first coil, we will create an electric current in the second wire.

The current in the first coil is usually called the primary current and the current in the second wire is the secondary current. What we've done here is pass an electric current through empty space from one coil of wire to another. This is called electromagnetic induction because the current in the first coil causes (or "induces") a current in the second coil. We can make electrical energy pass more efficiently from one coil to the other by wrapping them around a soft iron bar (called a core)

To make a coil of wire, we simply curl the wire round into loops or "turns". If the second coil has the same number of turns as the first coil, the current in the second coil will be virtually the same size as the one in the first coil. But (and here's the clever part) if we have more or fewer turns in the second coil. We can make the secondary current and voltage bigger or smaller than the primary current and voltage. One important thing to note is that this trick works only if the current is fluctuating in some way. In other words, you have to use a type of constantly reversing electricity called alternating current (AC) with a transformer. Transformers do not work with direct current (DC), where a steady current constantly flows in the same direction.

E. TYPES OF TRANSFORMERS:

b. STEP-DOWN TRANSFORMERS:

If the first coil has more turns that the second coil, the secondary voltage is smaller than the primary voltage.

This is called a step down transformer. If the second coil has half as many turns as the first coil, the secondary voltage will be half the size of the primary voltage. If the second coil has one tenth as many it has one tenth the voltage.

c. STEP UP TRANSFORMERS:

Reversing the situation, we can make a step-up transformer that boosts a low voltage into a high one

d. INSTRUMENT TRANSFORMER:

Instrument transformers comprises a large category of current and potential transformers for various voltage, frequency and physical size ranges. We have broken them up into several different grouping; low voltage, which are system voltages under 15kv; high frequency, operating frequency over 1kHZ; and size range from board mount parts up to current transformers with window sizes of 254mm by 610mm. read through the different types we supply we supply below and use our instrument transformer RFQ form to request a specific part to meet your requirements.

e. POTENTIAL TRANSFORMERS:

Used primarily in a step down environment to monitor voltage. They are designed for connection line-to-line or line-to-neutral in the same manner as ordinary voltmeters. The secondary voltage bears a fixed relation with the primary voltage so that any change in potential in the primary circuit will be accurately reflected in the meters or other devices connected across the secondary terminals.

Potential transformers can be used with voltmeters for voltage measurements or they can be used in combination with current transformers for watt-meter or watt hour meter measurements. They are used also to operate protective relays and devices, and for many other applications, since they are used in a monitoring capacity, they generally require much greater accuracy in design.

f. METERING TOROIDAL CURRENT TRANSFORMERS:

Traditional, window type current transformers for measuring 50-400HZ current of 5A to 15000A with secondaries of 0.1A, 1A and 5A (special secondary currents are available). Burden: B 0.1 through 1.8 (2.5VA to 50VA) with accuracy class: 0.2 to class 5.0 as per IEC 185 or class 0.3, 0.6 or 1.2 as per ANSI C 57.13. Inside diameters of up to 8.00". Many models are available as U.L recognized devices.

g. LARGE FRAME CURRENT TRANSFORMERS:

For measuring 50-400HZ current in bus bar and other large conductor systems. Typical configuration is 400A to 1200A primary current with secondary of 1A or 5A (special secondary current are also available).

Inside areas as small as 3.00" *7.00" and as large as 7.00" *27.00" and 10.00" * 24.00".all models are available with optional mounting plates for ""bulk-head" mounting. Some models are U.L recognized devices.

h. SPLIT CORE CURRENT TRANSFORMERS:

This type of current transformer is available to measure AC currents from 100A to 600A, at 50 to 400HZ. They are very popular in sub-metering applications where existing systems are being upgraded and it is impractical to isolate the primary conductor.it is even possible to install this type of transformer while the conductor is energized,

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however it is paramount that certain safety precautions be followed under such conditions. Rectangular in shape, standard split-core models are available with window dimensions up to 4.00” * 7.50”. Even larger, custom designed sizes are available by special order. Secondary ratings of 5A, 1A and 100MA are all common in spilt-core current transformers.

V. MINIATURE CURRENT TRANSFORMERS

These are constructed using one of the following methods: plastic casting, resin casted, resin dipped, tape insulated

Typical turns ratio: 4000:1 to 500:1 and accuracy class 0.1 to class 1.0

Application includes

- Energy meter for accurate current measurement
- Current control
- Current signature of motors
- Load sensing
- Ground fault sensing

3.2.9 DESIGN OF TRANSFORMERS:

N=10^8/4.44*f*H*A

Where

N=no of turns per volt

f=frequency=50HZ

H=magnetic flux intensity=60000 Ampere / meter

A=Area= (w)^1/2/5.58

W=watts

P=VI

P=12*2=24+losses

Losses=+\-3

P=27

A=0.931

N=8

3.3 DIODES:

Diodes allow electricity to flow in only one direction. Diodes are the electrical version of a value and early diodes were actually called valves

The schematic symbol of a diode is shown in below the arrow of the circuit symbol shows the direction in which the current can flow.

The diode has two terminals. Such as cathode and anode. If the negative voltage is applied to the cathode and a positive voltage to the anode, the diode is forward biased and conducts. The diode acts nearly as a short circuit. If the polarity of the applied voltage is changed, the diode is reverse biased and does not conduct. The diode acts very much as an open circuit. Finally, if the voltage VD is more negative than the reverse breakdown voltage (also called the zener voltage, VZ), the diode conducts again. But in a reverse direction. The voltage versus current characteristics of a silicon diode is shown in Figure

3.3.1 FORWARD VOLTAGE DROP:

Electricity uses up to a little energy pushing its way through the diode, rather like a person pushing through a door with a spring. This means that there is a small voltage across a conducting diode, it is called forward voltage drop and is about 0.7V for all normal diodes which are made from silicon. The forward voltage drop of a diode is almost constant whatever the current passing through the diode so they have a very steep characteristic (refer to current voltage graph)

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3.3.2 REVERSE VOLTAGE:

Through we say that a diode does not conduct in the reverse direction, there are limits to the reverse electrical pressure that can be applied. The manufacturers of diodes specify a peak inverse voltage (PIV) that the diode can safely withstand. If this is exceeded, the diode will fail and allow a large current to flow in the reverse direction. This voltage is also called the reverse breakdown voltage.

i. IDEAL DIODE:

For most practical applications the operating voltage is high, and the forward voltage drop is negligible in comparison. The voltage-current characteristics of a diode suggest that we can the following model of an ideal diode for all practical purposes (i.e., ignoring the forward voltage drop). The ideal acts as a short circuit for forward currents and as an open circuit with reverse voltage applied.

j. ZENER DIODE:

A zener diode allows current to flows from its anode to its cathode like a normal semiconductor diode, but it also permits current flow in the reverse direction when its "zener diode" is reached. Zener diodes have a highly doped, p-n junction. Normal diodes will also break down with a reverse voltage but the voltage and sharpness of the knee are not as well defined as for a zener diode. Also normal diodes are not designed to operate in the break down region but zener diodes can reliably operate in the region.

The device was named after clarance Melvin zener, who discovered the zener effect. Zener reverse break down is due to electron quantum tunneling caused by a high strength electric field. However, many diodes described as "zener" diodes rely instead on avalanche break down. Both breakdown types are used in zener diodes with the zener effect predominating under 5.6 V and avalanche breakdown above.

Zener diodes are widely used in electronic equipment of all kinds and are one of the basic building blocks of electronic circuits. They are used to generate low power stabilized supply rails from a higher voltage and to provide reference voltages for circuits, especially stabilized power supplies. They are also used to protect circuits from over-voltage, especially discharge (ESD).

G. RESISORS:

There is always some resistance in every circuit. A Circuit is always made up of some wire, so there will be some resistance there. Even the battery has parts thet offer resistance to the flows of electrons. The only circuits that come near to zero resistance are superconductors. This resistance that is from the parts of the circuit itself (especially the battery) is called INTERNAL RESISTANCE.

Notice the squiggly line just before the positive terminal of the battery? That's to show the internal resistance of the circuit. That symbol drawn any other place in the circuit, represents an actual placed resistor in the circuit. A resistor is a device found in circuits that has a certain amount of resistance.

If voltage is constant, then we can change the resistor to change the current. I=VR

If "V" is constant and we change "R","I" will be different.

H. DIODE RECTIFIER CIRCUITS:

One of the important applications of a semiconductor diode is in rectification of AC signals to DC. Diodes are very commonly used for obtaining DC voltage supplies from the readily available AC voltage. There are many possible ways to construct rectifier circuits using diodes. The three basic types of rectifier circuits are:

1) The half wave rectifier
2) The full wave rectifier
3) The bridge rectifier

In our project we are using full bridge rectifier in order to obtain a smooth waveform and perfectly rectified output as needed.

a. FULL BRIDGE RECTIFIER:

In many power supply circuits, the bridge rectifier is used. The bridge rectifier produces almost double the output voltage as a full wave center-tapped transformer rectifier using the same secondary voltage.

The advantage of using this circuit is that no center-tapped transformer is required.

Basic circuit operation:

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During the positive half cycle (Figure 3.5.1(A)),both D3 and D1 are forward biased. At the same time, both D2 and D4 are reverse biased. Note the direction of current flow through the load.

During the negative half cycle (Figure 3.5.1(B)), both D2 and D4 are forward biased and D1 and D3 are reverse biased.

Again note that current through the load is in the same direction although the secondary winding polarity has reversed.

b. FULL BRIDGE RECTIFIER WITH CAPACITOR FILTER:

The voltage obtained across the load resistor of the full wave bridge rectifier describe above has a large amount of ripple. A capacitor filter may be added to smoothen the ripple in the output.

The rectifier circuits discussed above can be used to charge batteries and to convert AC voltages into constant DC voltages. Full wave and bridge rectifier are more commonly used than half wave rectifier.

I. CAPACITOR:

Capacitors are electronic components that store filter and regulate the electrical energy and current flow and are one of the essential passive components used in circuit boards.

Major capacitor applications:

Decoupling: Enables sudden transfer of energy while maintaining stable voltage levels.

Filtering: It removes or filters unwanted AC voltage in applications such as AM ratio

Coupling: Blocks DC and passes AC component

Timing and wave shaping: set delay times in system such as wind shape wipers.

For full wave bridge rectifier:

Ripple=1.5*I (in mA)/C

C=1.5*0.002/1

C=3 microfarad

J. OPERATIONAL AMPLIFIER:

The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas includes transducer amplifier, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply system. for example , the LMI24 series can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional +15V or -15V power supplies.

a. UNIQUE CHARACTERISTICS:

1. In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

2. The unity gain cross frequency is temperature compensated

3. The input bias current is also temperature compensated

b. FEATURES:

1. Internally frequency compensated for unity gain
2. Large DC voltage gain 100 dB
3. Wide bandwidth (unity gain) 1MHZ(temperature compensated)
4. Wide power supply range:

Single supply 3V to 32V or

Dual supplies

5. Very low supply current drain (700 A)-essentially independent of supply voltage
6. Low input biasing current 45nA (temperature compensated)
7. Low input offset voltage 2mV and offset current : 5nA
8. Input common-mode voltage range includes ground
9. Differential input voltage range equal to the power supply voltage
10. Large output voltage swing 0V to V+/- 1.5V

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c. ADVANTAGES:

1. Eliminates need for dual supplies
2. Four internally compensated op amps in a single package
3. Allows directly sensing near GND and VOUT also goes to GND compatible with all forms of logic
4. Power drain suitable for battery operation

K. SILICON CONTROLLED RECTIFIER:

a. DESCRIPTION:

The 16tts12 is the SCR used. High voltage series of silicon controlled rectifiers are specifically designed for medium power switching and phase control applications. The glass passivation technology used has reliable operation up to 125oC junction temperature.

Typical applications are in input rectification (soft start) and these products and designed to be used with Vishay HPP input diodes, switching and output rectifiers which are available in identical package outlines. This product has been designed and qualified for industrial level.

L. TRANSISTOR:

a. Description:

Transistor is a semiconductor device used to amplify and switch electronic signals and electric power. It is of two terms “transfer of resistor”.

It means that the internal resistance of transistor transfers from one value to another value depending on biasing voltage applied to the transistor. Transistor here used is BC547. It is an NPN bipolar junction transistor. It is used to amplify the current. A small current at its base controls a larger current at collector and emitter. It is mainly used for amplification and switching purpose. It has a current gain of 800dB

A bipolar junction transistor (BJT) can be in three modes:

Cut of mode:

Transistor acts like an open switch between collector and emitter (i.e., collector-emitter “resistance” is infinite)

Active mode:

Transistor acts like a dynamic resistor between collector and emitter that adjusts its resistance in order to keep collector current at a set level (i.e., collector- emitter resistance is finite and positive).

Saturation mode:

Transistor acts like a closed switch between collector and emitter (i.e., collector-emitter “resistance” is very low). Trivial “switch” modes in the active mode, the transistor adjusts the collector current to be a version of the base current amplified by some constant>0. If the base current falls to 0, the transistor enters cut off mode and shuts off. When the base current rises too far, the transistor loses its ability to decrease the collector-emitter resistance to linearly increase the collector current. In this case, the transistor enters saturation mode. To keep the transistor out of saturation mode, the collector and emitter should be separated by at least 0.2V

c. IDEAL BIPOLAR TRANSISTOR:

Because the current gain is typically unknown or varies greatly with temperature, time, collector-emitter potential and other factors, good designs should not depend on it. In this laboratory, we assume that is sufficiently large (i.e., _>>1, where_=100 in our laboratory) so that IB=o and IC=IE

These simple rules are similar to the rules we use with operational amplifiers. The analysis approach usually follows these steps:

1. Calculate the transistor base potential VB by assuming that no current enters the base (i.e., IB=0).
2. Calculate the potential VE at the emitter of the transistor using VB. For an NPN transistor VE=VB-0.65V and for a PNP transistor, VE=VB+0.65V
3. Calculate the emitter current IE using the emitter voltage VE and the rest of the circuit.
4. Assume that IC=IE and analyze the rest of the circuit. Because we know VE, we usually know IE as well. So our IE dictates what IC should be

However keep these notes in mind. For an NPN transistor active mode requires VC-VE>0.2V. For a PNP transistor, active mode requires VE-VC>0.2. If this condition is violated, the transistor is saturated, and the analysis cannot continue using these simple rules. In design problems, change parameter (e.g. Resistors, supply rails, etc.) to prevent saturation. Sometimes it's easier to find VE first and use it to calculate VB. How "small" IB must be to neglect its effect depends on the circuit. In particular, IB * RB must be very small, where RB is the thevenin resistance looking out of the transistor base.

M. OPTO-COUPLER:

Opto-isolator or opto coupler, are made up of a light emitting device, and a light sensitive device, all wrapped up in one package, but with no electrical connection between the two, just a beam of light. The light emitter is nearly always an LED. The light sensitive device may be a photodiode, phototransistor, or more esoteric devices such as thyristors, TRIACs etc.

A lot of electronic equipment now a days is using opto coupler in the circuit. An opto coupler or sometimes refer to as opto-coupler allows two circuits to exchange signals yet remain electrically isolated. This is usually accomplished by using light to relay the signal. The standard opto-coupler circuits design uses a LED shining on a phototransistor-usually it is a NPN transistor and not PNP. The signal is applied to the LED. Which then shines on the transistor in the IC.

The light is proportional to the signal, so the signal is thus transferred to the photo-transistor. Opt couplers may also comes in few models such as the photodiodes. TRIAC of other semiconductor switch as an output. And incandescent lamps. Neon bulbs or other light source.

Most commonly used in Opto-coupler MOC3021 an LED Diac type combination. This IC is interfaced with a microcontroller and an LED is connected in series to the IC, which glows to indicate a logic High pulse from the microcontroller so that we can know that current is flowing in internal LED of the Opto-IC. When logic high is giving current flows through LED from pin1 to 2. So is this process LED light falls on DIAC causing 6 & 4 to close. During each half cycle current flows through gate, series resistor and through Opto-diac for the main thyristor / triac to trigger for the load to operate.

The opto coupler usually found in switch mode power supply circuit in many electronic equipment. It is connected in between the primary and secondary section of power supplies. The opto-coupler application or function in the circuit is to:

1. Monitor high voltage
2. Output voltage sampling for regulation
3. System control micro for power ON/OFF
4. Ground isolation

a. WORKING PRINCIPLE OF OPTOCOUPLER:

This is the principle used in opto-Diacs are available in form of ICs and can be implemented using a simple circuitry.

Simply provided a small pulse at the right time to the Light Emitting Diode in the package. The light produced by the LED activates the light sensitive properties of the Diac and the power is switched on. The isolation between the low power and high power circuits in these optically connected devices is typically several thousand volts.

The MOC3020 are designed for interfacing between electronic controls and power triac to control resistive and inductive loads for Vac operations. The principle used in opto-coupler MOC's are promptly available in integrated circuit form and don't require very complex circuitry to make them work. Simply give a small pulse at the right time to the LED in the package. The light produced by the LED activities the light sensitive properties of the Diac and the power is switched on. The isolation between the low power and high power circuits in these optically connected devices is typically few thousand volts.

b. FEATURES OF MOC3041:

400 V photo-TRIAC Driver Output
Gallium-Arsenide-Diode infrared source and optically-coupled silicon Triac driver
High isolation-500V peak
Output driver designed for 220 Vac
Standard 6-terminal plastic DIP
Directly interchangeable with Motorola MC3020, MOC3021 and MOC3022

c. TYPICAL APPLICATIONS OF MOC3041:

Solenoid/valve controls
Lamp ballasts
Interfacing microprocessors to 115/240 Vac peripherals

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Motor controls

Incandescent lamp dimmers

The circuit shown below is a typical circuit used for AC load control from microcontroller.one LED can be connected in series with MOC3021, LED to indicate when high is given from micro controller such that we can know that current is flowing in internal LED of the opto-coupler. The idea is to use a power lamp whose activation requires mains AC as opposed to a DC voltage. That's way the mains AC power that we're trying to switch the lamp and no external power supply is required. To switch the AC current to the lamp. We have to use an opto-coupler Triac, lamp and a Diac is shown in circuit below. A triac is said to be as an AC controlled switch. It has three terminals M1, M2 and gate. A TRIAC, lamp load and a supply voltage are connected in series. When supply is ON at positive cycle then the current flows through lamp, resistor, Diac and gate reaches the supply and then only lamp glows for the half cycles directly through the M2 and M1 terminal of the triac. In negative half cycles the same thing repeats. Thus the lamp glows in both the cycles in a controlled manner depending upon the triggering pulses at the opto isolator as seen on the graph below. If this is given to a motor instead of lamp the power is controlled resulting in speed control.

N. WORKING:

This is the working principle of the entire MPI current source. A 3 phase supply is distributed to the silicon controlled rectifier and low voltage supply is given to the control PCB. The control PCB contains the non-inverting amplifier, clipper, comparators, opto-coupler and pilot SCR these can be used to generate the PWM waveform. Pulse width modulation based voltage control technology is used to vary the firing angle of the SCR. SCR firing angle can be varied to vary the primary voltage of the current transformer correspondingly the varied secondary voltage is obtained. This AC voltage can be given to the bridge rectifier it converts that ac to dc voltage. The full wave DC (i.e. high current source) is applied across the test object such as springs, values and pipes. A magnetic flux is produced around the test object, if there is any crack means the flux path will be deviated through the crack, Magnetic Particle inspection such as ferrous iron particles are then applied to the part. The particles may be dry or in a wet suspension. If an area flux leakage is present, the particles will be attracted to this area. The particles will build up at the area of leakage.

VI. CONCLUSION

Using this type of MAGNETIC PARTICLES INSPECTION METHOD, the Magnetic flux density, magnetic field gradient, and magnetic forces on magnetic powder particles due to magnetic flux leakage at the site of a defect were calculated. These were used to determine optimum conditions for detection of different sizes and geometrics of defects in materials using MPI. Reduction of inspection design cost and time, and improvement of analysis of experimental data can be achieved by the use of High current source combined with careful incorporation of model parameters such as magnetic field source, magnitude of the applied current, defect size, position of defect and magnetic properties of both sample and magnetic particles.

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