



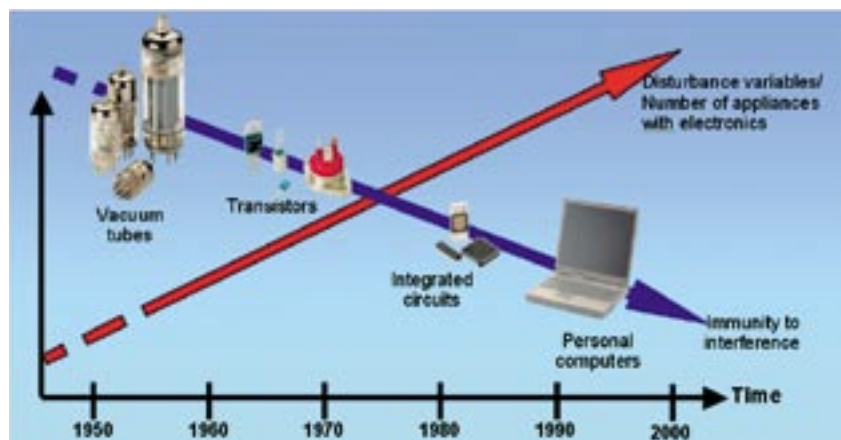
Nature's beauty is pleasant to mankind over the generations. At the same time, its fury is uncontrollable. One cannot forget the devastating tsunami or the hurricane floods which, even the most developed country like America could not able to cope up and asked for help from other countries. Nature's fury like tsunami and floods occur once in a while but it's after effects leaves bad memories for a long long time. Through the advancement in science, when we try to take edge over nature in arithmetic progression (like 1,2,3,4 etc), nature gives back strong reply by oeometric progression (like 1,3,9,27 etc).

Unfortunately, lightning is a daily phenomenon in many parts of the World, unlike the other nature's fury. Lightning activity is on the higher scale over the period of years as per the historical reports collected by Metrological departments across the world.

There are two major problems due to lightning. One is loss of Human life and the other is loss of property. Damage to electrical and electronic

gadgets are the ones due to loss of property. The safety measures to save Human life are out of the scope of this

article. Hence in this article, we will discuss about safeguarding electrical and electronic equipments. Today's mantra is plant availability. That is why, nowadays, we hear more often about 24x7 everywhere. Due to International competition, every Industry wants to increase the availability of their plant so that the production target is achieved. Also, loss of electronic equipments also causes huge loss of money because no company has maintenance budget related to lightning failures. The advancement in science takes us to back seat when we consider protection against lightning. On one hand, the size of the Electronic gadgets becomes smaller and smaller everyday viz, from room size equipments to desk top to laptop and palmtop. Though it is convenient because of its light weight, the energy level it can withstand reduces drastically. For example, IC can withstand energy only unto 1 micro joule whereas a transistor can withstand unto 10 micro joules. Relays and vacuum tubes can withstand much higher energy



levels when compared to ICs and transistors.

Disturbance Variables vs Immunity to Interference

The mushrooming of tall rise buildings - literally sky scrappers - are the potential source to attract lightning as the law of physics says tall objects are the preferred path of

lightning discharge. On the other day, an article appeared in the newspaper that Bangalore is going to have the tallest apartment in Asia with a height of 83 meters!

Failures happen due to 2 important reasons. One is obvious- direct hit in which the damage is visible because what we see we believe. The other reason, often un-noticed is distant lightning. In this case, lightning current is carried by electrical cables- no matter whether it is a power cable, or telephone cable or cable TV wire. Results say that the failure due to distant lightning is very much higher than the failure due to direct lightning. Hence many of us have experienced that, immediately after thunder showers, our phone lines stops functioning (more failures happen to cordless telephone charger) or our TV sets go bad. The myth here is, we have the general feeling that when the Telephone or TV is not in use - i.e. when they are in switch off condition, they are safe! But the fact is, they would have been safe if its connections were physically removed from the respective sockets - for example, for a TV to be completely safe, its power cord and cable TV connection should have been physically removed from their socket. How many of us do this on day to day life? We might have thought that there won't be any thunder showers and hence would not have disconnected on a particular day. Suddenly in the late night, during our sleep, thunder showers would have formed with the result of failed equipments to be seen only the next day when we try to use the gadget. Even if we are systematic, we can't adopt in our place of work because in a huge complex, which has thousands of gadgets and which work 24 hours a day, how do we achieve this? Hence, the only way to protect them is by using SPDs - Surge Protection Devices. Internationally recommended term is Surge Protection Devices though different countries and manufactures use different names

- some of them are TVSS (Transient Voltage Surge Suppressor) lightning arrestors, lightning barriers, surge arrestors, surge barriers, lightning protection units (LPU) etc.

Before talking about SPDs, let us first understand what is surge and how it is going to affect our electronic equipments. Then, it will be easier to adopt suitable SPDs for protection of equipments.

What is Surge and how they are caused?

Put in simple terms, surge is abnormal increase in current and voltage for a very short period of time (duration of 10/350 microsecond or 8/20 microsecond). There are various sources of surge. The two major classifications are surges generated by mother nature (due to direct lightning hit- which is very rare or distant lightning- which is very common) and man made transients (sags due to brown out, black out, capacitor switching, frequent switching on/off of heavy duty equipments, welding, electro static discharges etc). Unless the protection techniques are properly employed by experienced and specialized consultants in this field, failures may happen within an year of commencement of new plant. A simple example is, think of a temperature milli volt signal from a thermocouple, the wires of which run along with 415V AC, 3 phase power line. Any small change (swell) in the power line will affect the Mill volt signal due to electro-magnetic induction. This will induce more obvious errors in a mill volt signal which is already a very low level signal when compared to 415V AC, 3 phase power line. The result will be un-wanted tripping in the DCS (Distributed Control System) or PLC (Programmable Logic Controller) or SCADA (Supervisory Control and Data Acquisition), which is not due to any change in the measurement signal.

Many feel that unless they see a charred PCB they won't accept that

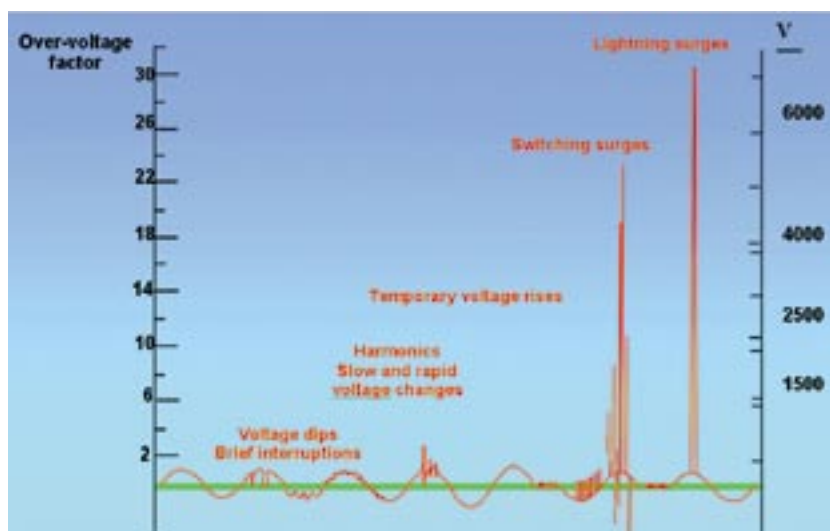
the problem is due to lightning/surge effects. This is not the only effect due to surge as we normally believe. The more common problem we can encounter in the normal plant life is corruption of EEPROM (Electrically Erasable Programmable Read Only Memory). This is visible form the sudden junk data appearing in the MMI (Man Machine Interface) panel. Though it is common practice to put that loop of PLC or DCS in manual mode, remove the corrupted EEPROM, erase it in UV eraser, re-program it in the EEPROM programmer and put it back in to operation. If we examine, why such corruption of EEPROM suddenly takes place, the reason will zero down to surges. Because, what is actually done is, while programming is in operation, a voltage higher than normal working voltage is applied to particular pins of EEPROM, (so that EEPROM understands that, it is in programming mode and not in normal operating mode). The same thing happens during a surge. A sudden high voltage appears to those pins of IC, hence it believes it is in programming mode and the ones and zeros changes randomly so long as the extra high voltage appears in the pins. This is nothing but EEPROM corruption.

Hence failure or corruption is entirely due to the intensity of the surges. Actually electronic equipments are built to withstand a small increase in voltage levels which is well within the tolerance limit. If surge of magnitude up to this level appears, nothing happens to equipments. The second level of surges is called degradation. These levels are higher than the normal tolerance limit but below the level to make the equipment to fail permanently. Experience tells that in more than 90% of the cases, it is this degradation that happens to the equipments. It will take sometime for the equipments to reach the permanent failure level. It can be few days to several months. But this is the most unpredictable problem for

the maintenance engineers because the problem is intermittent and will appear at different point of time. For example, an Analog Input card of DCS or PLC would have been affected due to lightning on a particular day to the degradation level before it fails permanently after some days or months of operation.

Modern electronic equipments fail predominantly due to two reasons. One is called steady state failure and the other is called transient failure. Steady state failures or errors are due to Harmonics and RFI/EMI effects. Transient failure or error is due to surges which is either from lightning or from internally generated switching surges, welding etc. RFI (Radio Frequency Interference) and EMI (Electro Magnetic Interference) are one and the same. In earlier days, only when radio equipments were there, it was called RFI. As we have many different types of equipments now, it is called as EMI. We will restrict our scope here only to problems that are happening due to transient or surge failures.

Disturbance Variables in Low Voltage Networks



Over Voltage factor: it is the number of times, the over voltage is above the nominal voltage. For example, if the nominal voltage is 230V, 2 means 460V, 6 means 1380V and so on. V: required protection level (surge protection category to IEC 60364-4-44 and DIN VDE 0110, Part 1

Common Myths

Generally we feel that SPDs are not required as we have number of other existing arrangements / gadgets to protect Viz, External Lightning Arrestor (also called as air terminal), MCB/MCCB, good earthing, bonding, shielding, Isolation transformer, UPS, Intrinsically safe barriers, isolators etc. Unfortunately the application of all these equipments are for different purpose altogether and not for protecting equipments from surges. Let us analyze the scope of each one of them.

External lightning protection with good earthing: is for protecting the building or fabric from direct lightning strike. That is when direct lightning hits a building which is not fitted with Air terminal, the building will be damaged. Air terminal provides the safe path for the lightning current to reach the ground through down conductor without damaging the building.

MCB- Miniature Circuit Breaker or MCCB - Molded Case Circuit Breaker is for protecting equipments from short circuits due to flowing of fault current. MCB or MCCB operated in milli second duration. Surges are of micro second duration which means before MCB

or MCCB can detect surges, it would have already passed through them and damaged the equipments.

Earthing is for both personal safety and for equipment safety.

Bonding is to reduce the earth resistance because reducing earth resistance beyond certain value is very difficult and is also very costly. Mere bonding of 2 earths reduces the total earth resistance by more than half value. For example, if one earthing is of 2 ohms and the other one is of 3 ohms, bonding these two brings the equivalent resistance to 1.2 ohms. In cases where bonding the two different earths are practically not possible or recommended, it can be done using special SPDs.

Shielding is done to protect equipments from RFI/EMI effects.

Isolation transformer is mainly used to protect equipments from the faults that happen at the primary side. For example, in case of a short circuit in the primary side, the equipments connected to secondary side will not be affected, if they are connected through Isolation Transformer.

UPS or Un-interrupted Power Supply, as the very name suggests are used to provide continuous power through battery in case of mains power failure or to regulate the power within narrow band.

Intrinsically safe barriers or isolators are basically used to Hazardous Plants (for example, refineries, Petro -chemical plants, fertilizer plants etc) to restrict the electrical energy to very low levels so that even in case of any short circuit the available power is too low to ignite spark or fire.

Hence SPDs are the only source of protecting Electronic equipments due to surges. In the concluding part of this paper, we can discuss about various types of applications and the proper selection and installation of SPDs for trouble free operation of equipments.