**AC / DC – Not Just Rock and Roll**
**Power Supply Choices for Timing Systems**

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Every season a handful of our timing system clients run into trouble because they make some basic mistakes about how they power their timers or their timing sensors and accessories. There are some very important pitfalls to avoid on this topic because you can cause timing problems or inaccuracies, damage your equipment and even put your operators into serious danger of fire or electrical shock. Any external power supply, be it a battery (DC) or household current adapter (AC to DC) for timing systems, needs to be carefully considered.

In order of preference, here is how we recommend you power your timing devices:
a) Fresh Internal Alkaline batteries.
b) External Battery (Alkaline or rechargeable Nicad, NiMh, GelCell or sealed Wet Cell)
c) External High Quality 110vac/DC Adapter (preferably the one sold by the Manufacturer)
d) Internal Rechargeable NiCad Batteries.
e) Nothing Else.

In all cases, how your timing system uses power is related to the “Ground” characteristics of the timing inputs. You may be solving one problem (power supply) and causing many more (false or erratic timing pulses or much worse). Although you can fix some of these power supply problems with adding other devices (opto-couplers, isolation transformers) it’s best to deal with the fundamental issue rather than just treat the symptom.

**Not Just Power but Timing Too**
Most timing systems sense incoming timing pulses from sensors like start gates, photocells, manual buttons, tape switches and many other sources as “normally open” or “normally closed” pulses on a pair of wires. There are many other ways this can be done, but for the most part our ALGE, TAG Heuer and Swiss Timing systems use these methods. It’s sure-fire and very market compatible with many other makes of high-quality sensors. The whole concept works on how a timer senses changes in the sensor connection relative to the “Ground” –side of the Timer inputs. As described above, the Ground is also part and parcel of the “negative pole” of whatever your timer is using as its power source. If you mess with the power supply of your timer, sensors, display or anything else connected to your “system” (like a PC, Laptop or printer), you are also playing with the ability of your timer to properly sense incoming timing signals.

If you inadvertently use a compromised external power source you will probably compromise the timer’s ability to “look” at what it assumes will be a stable “Ground” or “Zero Volts” reference point. False triggering is a real threat in this case, and that may be the least of your problems.

In addition, any external power supplies that do not provide a “close-to-pure” Direct Current (DC) at the required voltage will not only mess with the nature of the Ground reference for timing accuracy, they can destroy the internal power circuit and possibly affect other operational circuits of your timer. This can occur over time or more dramatically, sooner.

**Internal Needs**
Almost all electronic circuits from cell phones to video cameras are designed to operate on Direct Current (DC) Voltages. Even if you can plug them into the wall in your house (That’s Alternating Current – AC), inside of the device the AC is converted into a useable “Ripple” free DC current at the required voltage on the circuit boards. The term “Ripple” in this case refers to the presence of Alternating Current (AC) on what should be a Direct Current (DC) power supply. Depending on the sophistication of the device and the importance of the task, the purity of the DC current inside the device may be allowed to vary. Manufacturers may also have to be very careful about what they expect the AC voltage to be if they expect to convert it into the DC they need inside the device. Since typical AC supply voltage can vary greatly (household AC can be anything from 100

vac to 140 vac in some cases) if you need 5 volts DC inside the device you had better build a power circuit that can take pretty well anything in that expected range and deliver exactly what is needed for the circuit in terms of DC. Not surprisingly this effects the cost of the power supply or circuit that is built to do the job.

**Power Supply Options**

The best example of a ripple-free DC power source is a battery. Batteries are pure DC. They push electrons into your device in one very predictable direction and do so until they run out. The up side is they are the best DC source of energy and have no adverse side effects. The down side is they have a finite capacity.

To keep you from constantly buying exhaustible batteries, a manufacturer will propose or provide a household current (110 Volts AC) adapter that allows you to plug into the wall and power your device from a now theoretically inexhaustible and relatively inexpensive Alternating Current power source. This can take the form of a built-in circuit or more typically and annoyingly an external “wall-wart” adapter.

Timing systems are sensitive to the power you feed them because they are trying to do very precise things. This is why we want you to use alkaline batteries if you have a choice. Alkaline batteries have a very predictable discharge rate (they start around 1.6 volts DC and provide useable current to around 1.1 volts). Put in new ones, watch the power LEDs or meters for readings and you can be assured you will have a complete timing session with no worries about induced problems from external power sources.

However, since the stability of the negative “ground” of the timing inputs is related to the quality of the power your are hooked to, you can mess up a good thing pretty easily with an inexpensive but ripple-laden AC external power supply that is supposed to be delivering nice clean DC voltage but probably isn’t able to.

**The Reality of What’s Out There**

Sports venues like ski areas, arenas, velodromes or anywhere a temporary AC power is added can pose basic technical challenges. At a ski area it is common to find that the timing building will be hooked into the AC power line that also services the lifts, snowmaking or general large current resort power. These AC lines will typically have large motors working on them driving lifts, compressors, heating or air conditioning units, refrigerators, etc. All of these large capacity motors actually feed back AC “noise” into the AC lines that supply them because of the enormous electrical load they represent as they operate. This may be, and often is, the same AC line that your delicate little timer may be hooked into in the timing building. This AC feed-back noise from these large AC current users will cause the AC line to exhibit disturbing and potentially harmful characteristics that are related to AC harmonics. These feed-back harmonics are powerful electronic waves that can easily destroy more delicate electronics like your timer and/or laptop. Every situation is different and the load harmonics generated can vary enormously.

To counteract these large load AC harmonics effects, resorts and venues use isolation transformers on their AC lines to isolate the large AC motors from other everyday users in the general AC loop. Again, it is not uncommon to find that for your timing building the area may have simply tapped into an existing AC line for the lift without installing an isolation transformer to protect your equipment. After all, these transformers have an associated cost. A general model of this problem would be like a series of hoses attached to a water main. Some hoses are bigger than others to accommodate a greater flow (current) at a particular pressure (voltage). If your timing building requirements for power were simply tapped into a much larger “hose” servicing the power needs of a lift, if the lift suddenly shuts off there will be a momentary backwash of current into your little offshoot hose. Without some way of isolating this effect you can easily see that you’re going to get more juice than you ever expected or need. In the world of electronics, these effects happen in microseconds so it does not take long to generate an unwanted effect. Even if the lift never shuts off unexpectedly, just being hooked into the same conduit that services that large motor will induce harmful waves back into your little offshoot connection during normal operation.

**Generating Interest**

AC generators are a no better solution as they have their own problems. Unless you work with a high quality generator installation, the AC current and voltage you get may vary tremendously, and the actual quality of the AC wave-form being produced (known as a Sine Wave) may not be what your power adapter can handle.

More commonly these units are almost never properly grounded so any fault in any attached electrical equipment can destroy the device or even worse can cause severe electric shock that may kill you.

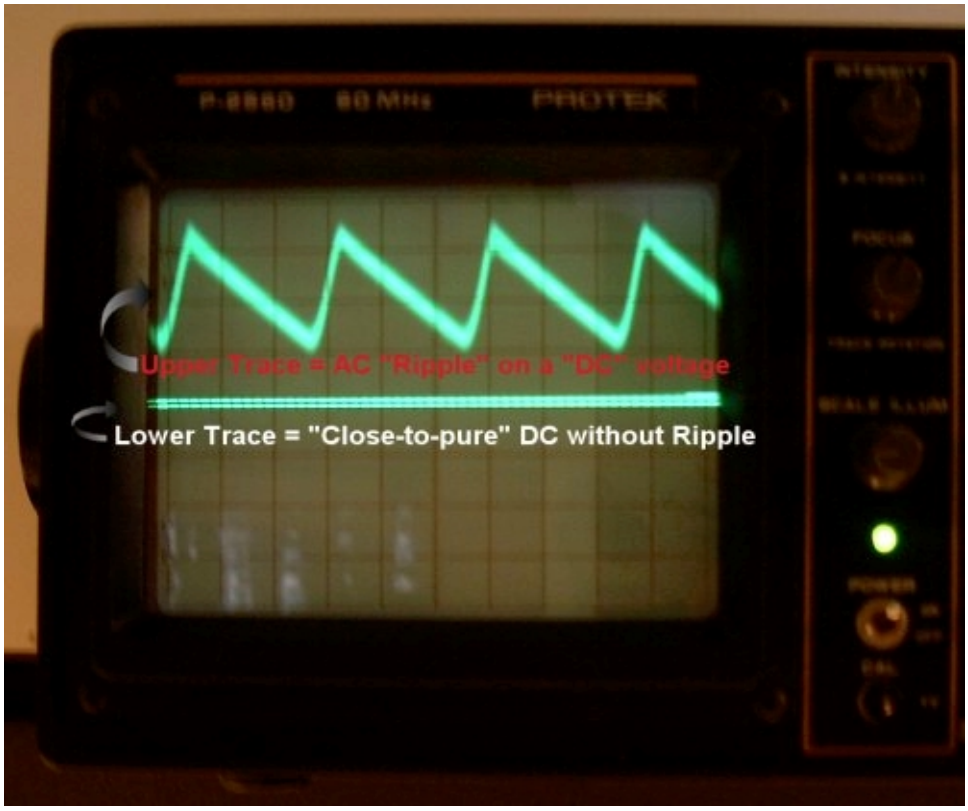
Because all of these issues have happened to us on tour, I advise my clients to be extra cautious when using any device hooked to an external AC source. Either the quality of the AC adapter is an issue, or the characteristics of the AC source itself can be compromised. If you don't know what you're doing in this regard, get a qualified electrician to asses your venue.

**Practical Suggestions**

Timing system manufacturers like TAG Heuer and ALGE sell you specific AC adapters that are designed to meet their criteria for DC delivery of power to your timing system. Not all AC adapters are created equally, and like most things in life it is the hidden qualities that make the difference. They cost more because they are excellent AC to DC adapters capable of filtering out pretty well all of the AC ripple and delivering the required voltage irrespective of current demand by the timer or voltage supplied from the wall.

Some of our clients get creative and buy cheaper AC to DC power supplies, even battery chargers, and hook them up to their timers as the external DC source. For these people they incorrectly assume that a $9 AC to DC 12 volt power adapter will do what it says it will do. Incorrect. Just because it says 12vdc on the box does not mean that's exactly what you are going to get when you plug it into the wall socket.

Included here is an oscilloscope screen picture of the unseen difference quality makes and proof that things are not always as advertised on the box. The photo shows two trace lines. One is flat, the other is "somewhat jagged" (understatement). The lower flat line is a trace of almost pure DC being delivered from a TAG Heuer AC to 12VDC power adapter. The upper jagged trace is that of another power supply source that is supposed to be "DC" being delivered by a locally available AC to DC adapter of lesser quality.




The obvious difference you can see is that the what-is-supposed-to-be "DC" coming from the upper trace example is really not very good DC voltage at all. The jagged line represents AC "ripple" noise that is sitting on the "DC" wave that has not been entirely eliminated from the wall AC source. Not only that, the voltage is nowhere near the as-advertised 12 volts and is in fact closer to 17.6 volts. The Timer expects and demands close-to-pure DC to operate properly, but it would in this case be subjected to damaging AC ripple and noise. It's hard to tell what the voltage would be because that would depend on the load. At the very least this can cause false triggering on the timing inputs (remember that the zero-volts "Ground" of the inputs is directly related to the negative side of the DC power supply). If connected to data devices like a PC, printers or a display, AC ripple like this can easily disturb the data signals and cause data to be dropped or to become unintelligible at certain transmission speeds. Over time this presence of AC ripple on what is supposed to be a pure DC supply voltage can damage the internal timer circuits.

Note that this power pheomenon also pertains to any device you hook into your system. That goes for sensors, display boards, voice communication, computers and printers, etc. Any time you add a device to your timing system that is in some way connected to AC "household" current, you're injecting a suspect point

of potential trouble, damage or failure. They all connect together via the ground side of your data or sensor triggering connections.

**All Charged Up with Nowhere to Go**

A classic case of this cascading problem is found when people try to charge large automotive 12vdc batteries with car chargers when their displays or timers are also connected to them. Some deranged logic suggests that it's "ok" to attach a $20 charger to a car battery and your $ 3,500 display simultaneously. As a result we get one or two charred remains of circuit boards from displays or timers each year. The damage is caused by the "DC" chargers that are doing their best to jam AC laden current into the DC battery leads while the race is going on. This is fine if you want to make toast, not so good if you're into accurate timing and the long life of your electronics investments. The charger is not at fault, but the operator is. If it says "charger" on the box, use it for charging only, not as a power supply during operation.

**NiCad / NiMh / Gell Cells and Other Options**

If you just can't bring yourself to trust alkaline batteries (some people are like that, mostly because they understandably don't want to buy batteries and keep throwing them away) please contact your dealer to get the appropriate AC to DC adapter, or opt for an external rechargeable GelCell battery and the correct cable. In some cases you can use rechargeable NiCad batteries that may be able to be charged in the timing device, or you may have to charge them in a separate charger. I would warn you however that you should in all cases stay away from Nickel Metal Hydride (NiMH) batteries for low temperature applications. NiMH batteries are fine for temperatures above 5C but NiCads are better in the cold. Again, rechargeable high-capacity (1 Ah or more) NiCads are a good option, but be advised that they have a nasty tendency to be unpredictable in terms of capacity and it is virtually impossible to gauge their voltage vs. capacity state since they start at 1.2 volts and fail rather abruptly just below that value.

**Summary**

If you have a timing system problem that crops up, investigate the power sources first. Most problems are related to bad AC adapters or the nature of the AC source itself. Avoid the urge to come up with a cheap power solution because you can't understand why Radio Shack sells an AC power adapter for $ 9 and ours is $75. There is a difference and the price reflects that appropriately. If you're stuck you can in fact find very good AC to DC power adapters at places like Radio Shack, but they're not the $9 flavor and they probably won't come with the plug you need.

This is the area where our clients tend to have problems if they have problems at all. Dead batteries, bad AC power, inappropriate use of rechargeable batteries, incorrect external power cables, and not understanding the effects that other connected devices that are connected to AC power may have on the system as a whole. Please be safe and pay attention to the details of the manufacturer's recommendations.

Please contact me if you have any questions.

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