Amplifone HV Guide 1.1 by Michael Kelley, 6/9/1999

I wrote this with the help of several people, and hopefully this will be of some assistance to those who decide to restore Amplifone monitors for their Atari Color Vector games. I plan on doing an addition covering Amplifone Deflection boards soon. Gregg Woodcock's Vector Faq is excellent; I learned a great deal about WG Color X/Y monitors. However, it goes into little depth in covering Amplifone HV and Deflection boards. That's why you are reading this. If you have any corrections or comments, please let me know.

I would like to thank these people: Joe Welser (who wrote the first known Amplifone HV guide, and helped me several times with great advice), Gregg Woodcock (who gave me a greater understanding of Vector monitors through his faq), John Robertson (who developed the WG6100>Amplifone HV mod), Randy Fromm (for being the greatest tech in the world, as well as a great teacher - "Grasshopper, you crazy to mess with the Amplifones!") and last, but certainly not least, Ed Henciak, who was always there to help me fix everything when it blew up.

>>>>>>>>>>>>>>>>>>>>Disclaimer<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

Working on monitors can be dangerous. You are dealing with high voltage equipment, as well as a potential risk of implosion of a picture tube. I take no responsibility for damage to yourself, or your equipment. If you are unfamiliar with high voltage systems, DO NOT put yourself in danger. Get someone qualified to work on it, and watch and learn from them. I suggest Randy Fromm's video tapes on Monitor Repair to learn the basics and proper safety steps for working on monitors. If you choose to jump in and work on your monitor without any knowledge of what you are doing, I can assure you, you will damage your equipment, and quite possibly yourself.

>>

It's worth it

I've had many people (especially operators!) look at me like I was crazy for wanting to restore Amplifone Monitors. Their look gets even more wide eyed when they find that I am replacing a perfectly good Wells Garner color X/Y with an Amplifone. Why replace a nice working WG?? Without getting technical, simply look at the picture of a tuned up WG and compare it to a Amplifone in similar condition. I think you'll be amazed at the difference. The Amplifone has a higher refresh & slew rate, and the Amplifone tube is medium res. The result is a sharper picture that simply looks better than any WG. You are seeing the picture the way it was supposed to be, when games like Star Wars, Major Havoc, and Quantum appeared when they were new around 1982-1985.

The problems with the Amplifone HV Transformer and HV boards are infamous, and many have called it the "trashifone", as well as several other names that won't be mentioned here. However, consider the reliability of the Amplifone deflection board. Also, (with the help of this faq) the HV board can be made to be very reliable. The picture on a tuned Amplifone will blow away your best WG, mark my words. Restoring Amplifones can be VERY worthwhile. When you see the picture of your favorite Atari color Vector game on an Amplifone (for the first time to many of you) I think you'll agree "it's worth it".

Schematics

When using this guide, you'll be VERY confused unless you have a nicely printed schematic of the HV board. The schematic available on GameArchive (Thanks Jess!) (http://www.gamearchive.com) is helpfull, though it does not show the 5w 50ohm resistors for some reason. It does show the 1N4001 diodes at the +/- 24v regulators. However, it lists C3 and C4 as 100uf @35v. This is BELOW what I recommend - see the

section on caps(**) later in this guide. If you have any different schems for the Amplifone HV board, please let me know.

HV board revisions

I am aware of 3 HV board versions. Let me know if you find any others, I'd like to document them here. The earliest feature no 50 ohm 5w resistors and no 1n4001 diodes at the +/- 24v regulators. As far as I know, this early revision was allways blue, though there are later factory modded blue boards with the 5w resistors and 1n4001's at the regs. Other colors of Amplifone HV boards are beige and green. They are all labeled A201012, and this is sometimes followed by -01,-02,-03. (Note: the -01,02, and 03 do not allways indicate the revision.)

The early blue boards (with no 5w resistors and no 1n4001's at the regs) are pretty scarce, I understand that they only appeared in Quantum. The blue boards that have been factory modded with the 1N4001 diodes and the 5w 50 ohm resistors at the regs may have appeared in early Star Wars machines, as well as the Tholian Web MH prototype and other prototypes.

Quantum was the first arcade machine to ever use the Amplifone. Though there are references to Gravitar and Space Duel using the Amplifone, I've yet to see or even hear of a Gravitar or SD cabinet with Amplifone racks inside. If you see one of these, please let me know. The beige and green HV boards are pretty common, these were found in both SW and MH machines. Another point worth mentioning is that the same Amplifone HV board (and deflection board) is used in both the 19" and 25" monitor (25" found in SW cockpit) and both monitors run their HV at 19.5kv.

Blue Boards (or rev.1, with no 5w 50 ohm resistors and 1n4001's at the regs)

Blues without the 5w resistors or diodes at the regs are really rare, but before anybody gets any E-bay ideas (joke), they might only be worth something to the person who needs that particular # board to match all their #'s in their Quantum. Unmodified, these are for use ONLY in a Quantum machine. Throw a stock blue in a SW or MH, and you run the risk of blowing your 24v regulators, killing your MPSU07, your BU406D, and your precious HV transformer.

Blue Amplifone HV boards have some obvious differences from the other boards that are very easy to spot. The easiest thing to notice is that on the Quantum series blue boards, there are no 50 ohm 5w resistors accross the 7824 and 7924 regulators, and their are no 1n4001 diodes at the regs. These were put on the later boards to reduce transient voltages to the regs during stressfull times for the monitor in games like Star Wars (Death Star blowout) and Major Havoc (space sequences, wide explosions, etc..) The 5w 50 ohm resitors are not manditory in Quantum, though it won't hurt to add them. In my opinion, the 1N4001 diodes at the regs are a "must have" in ANY machine. If you plan on using the blue HV board for anything other than Quantum, the resistors are a "must have". Quantum does not "stress" the monitor nearly as much as MH or SW, so adding the 5w 50 ohm is optional if the board is just for Quantum. However, you should add the diodes REGARDLESS of what the blue board is used for.

Some big difference on the blue appear in the HV overvoltage section. This can get REALLY confusing becuase these differences do NOT appear on any schematic that I have seen. You'll notice there is no component in the spot marked R18. There is a 1k resistor piggybacked to the .01uf 50v glass capacitor C9. This resistor has its own spot and is labeled R19 on the beige and green board. It also appears as R19 on the schematic. R16's spot on the blue board has a 1N754A zener diode in it, this is actually CR4 on the schem and on the beige and green board. R16 in the schematic is shown as a 470 ohm resistor, and R16 is a 470 ohm resistor on the beige and green board. R19 on the blue is 68k, this goes from the base of Q5 (2N3904) to C10 (.1uf @50v) and the anode side (line side) of the Zener diode (1N754A) in location R16. There is no R19 listed on the schematic, and no R19 appears on the beige or green boards. Also, when comparing the blue board to the newer beige or green boards, the over voltage LED is oriented in reverse. (The anode (line side) faces away from the focus assembly instead of twords it on the beige and green board.)

Amidst all this confusion, the key thing to remember is that the overvoltage section (where all the above differneces are) is essentially the same as the one in the schematic, and on the green and beige board. These differences can be VERY confusing when trying to follow a schematic. I have yet to see a schem that

acurately covers the blue board, if you find one, please let me know. It would be a great help. Perhaps someone could make a picture illustrating the above differences? I really am no good at text pictures...

As mentioned before, there are some factory modded blues with the diodes mounted to the back (solder side) of the board across the regs, and the 5w 50ohm resistors on the parts side. If these components test OK, you can skip the next section and feel very lucky...

Adding the 5w 50 ohm resistors and Diodes to your early Blue board

These resistors go from pin 1 of the 7824 to pin 3 of the 7824, and across pins 2 and 3 of the 7924. You'll have to drill 4 holes in your HV board for the resistors. For the 7924, I drill a small hole (only big enough for the resistor lead) in the middle of the trace that runs to pin 2 and goes to the minus side of C2 (470uf @ 50v**), and another hole right next to the triangular trace that leads out from pin 3 of the 7924. (This is the trace that combines the minus end of C4 (100uf @ 50v **), and one end of C13 (.1uf @50v). If you follow this trace all the way up the board, it leads to the emitter of the BU406D, labled E on the parts side of the board.

For the 7824, I drill 2 holes near the middle of the board. Look at the board solder side up, and orient it so that the focus assembly is on the right, and the long black heatsink bar is closest to you. Measure 3" in from the right edge of the board, and 2 & 1/2" up from the edge that is closest to you. This is the first hole. The 2nd should be 3 & 15/16" in from the right side, and 2 & 1/4" up from the edge closest to you. You should use heat RESISTANT tubing (not heat shrink tubing). This is available from Mouser, TechAm, and Housefelt. Use this to insulate the leads on these resistors. These resistors can get HOT. You want to make sure there is sufficient distance from any critical components on the board. I've seen the heat from these resistors damage components they are close to, as well as the board itself, so mount them safe.

The very early Blue board is also missing 1N4001 diodes on each regulator. These should be installed on the early Amplifone HV board, NO MATTER WHAT game it goes in. You can drill holes to surface mount these, or mount them on the solder side. If you choose the solder side, you'll want to insulate the leads with heat shrink or clear plastic tubing so they don't cross any traces. They go at the outputs (pin 3) of each reg to ground. On the 7924, the cathode side (line side on the diode) goes to ground, on the 7824, the cathode side goes to the +24 output line coming from pin 3 of the reg. Again, PUT THESE DIODES ON THE BOARD no matter what game you are running. Keep in mind that many of the later blues had the diodes on the solder side of the board, so look before you go drilling.

Beige and green boards

The biege and green boards are revised with the 5w 50 ohm resitors and 1n4001 diodes at the regs. If you see one without this "standard equipment" please let me know. As far as I know, the beige boards appeared after the early blues, and the greens were found in later SW and most all MH machines. Here are the differences I've seen:

The values of C3 and C4 (more info on capacitors later**) are often 220uf @ 35v insted of 100uf @ 35v found on early blue boards.

C8 (.033uf, poly on blue board) is now a rectangular plastic case on most green and beige boards, but is rated the same.

All beige and green boards have the over voltage LED mounted so the anode (flat edge side) faces the focus assembly.

The orientation of the 20k HV overvoltage pot R17 on some green boards is sometimes sideways when comparing its orientation to R7 (the frequency adjustment pot to the 555 ic)

Note: I have seen a few beige boards with a layout just like a blue (C9 jumpered with 1k resistor, nothing in the R18 spot, no surface mount diodes at regs, no R19 on the board) but all of these had the 50 ohm 5w resistors on the parts side, and diodes at the +/-24v regulators mounted to the back (solder side) of the

board. These boards look a bit smaller, but in every other way are identical to the newer modded blue board. The overvoltage LED faces anode away (line side) from the focus assembly, like a any other blue. Again, make SURE your leads to your 1N4001's are well insulated! (on boards with the diodes on the solder side) The older hard plastic insulation used on these diodes at the factory can deteriorate over time, and if a lead shorts traces on the board, you're going to have a blowout.

Changes that should be done to all Amplifone HV Boards

1N4001 diodes at the regs

As mentioend before, you should add these diodes no matter what game your HV board is used in. These diodes are on all boards except for the very early blues. Remeber to check the back of the board; many later blues and some small beige boards have them mounted on the solder side.

IMPORTANT>>>>> Make sure your leads to your 1N4001's are well insulated! (on boards with the diodes on the solder side) The older hard plastic insulation used on these diodes at the factory can deteriorate over time, and if a lead shorts traces on the board, you're going to have a blowout.

5w 50ohm Resitors at the +/- 24v regulators

As mentioned extensively before, these can be added to any board, and are required on all boards not used exclusively in Quantum.

Common Electrolytic Capacitor Changes**

These cap changes apply to ALL Amplifone HV boards. First, use 105 degree low ESR caps. I believe Bob Roberts (http://personal.msy.bellsouth.net/msy/b/o/bob147/) has these at good prices. He might be stocking Amplifone cap kits now to cover all your needs. Zannen Electronics (806-793-6337) also sells Amplifone cap kits, and I've heard Aubrey's stocking 105 degree low ESR's now. However, I don't know if any of these kits are at the values that I use below. Some of my suggestions below are OVERKILL, but when I work on one of these boards, I usually don't have to work on it again. If you want to use the values I do, here they are:

C1 & C2: 470uf @100v
C3 & C4: 220uf @ 50v
C5: 4.7uf @ 100v

All should be 105 degree low ESR's.

+/- 24 Volt Regulators

Go with the 1.5 amp rated 7824CV and 7924CV, instead of the 1 amp rated originals. These are available through Mouser (http://www.mouser.com). On most boards, you'll see that the 7824 is NOT insulated to the heatsink bar using a case insulator and heat sink compound. Only the 7924 (VR2) should be insulated. You should replace the "rubber" style insulator on the 7924 with a mica insulator and a good coating of heat sink compound. The older style rubber insulators can deteriorate, and it is best to replace it while your working on the 7924. You can get TO220 insulators and heat simk compound from Mouser as well. Use a light coating of heat sink compound, and apply an even coat to the back of the regulator. Then, put a light coating to the back of the mica insulator where it will contact the heat sink bar. Tighten the screws so they are pretty tight, but don't overdo them. I put the screws in first to hold the reg in place, then solder it to the

board. Make sure your solder joints are very good at the board. This is a spot that will make a cold joint if your initial joint is not good.

Solder Joints

I suggest doing all joints where the harness wires go to the board. I usually heat the joint up, and use a soldapuller to remove all of the old solder. Then, I resolder each wire. After you do this, check for good continuity between each joint at the board, and it's endpoint on the harness. You'll have to open your neck connector to check the joints at the pins. You can usually do this using 2 small screwdrivers. Be careful not to crack your neck connector when opening it. While you're checking continuity, make sure the DAG ground connector is good, and make sure its pins are in tight. I check DAG ground continuity from the board to the DAG spring on the CRT.

Some other joints that are common problems are those at all the electrolytic caps, the MPSU07, the BU406D, the +/- 24v regs (mentioned before), joints on the HV transformer, joints on the MCI (red mystery can), and ALL wires to the focus assembly. You also will want to make certain your wires to the focus assembly and anode cap are well insulated and don't have any cracks.

BU406D (Q2 on schematic)

This transistor is critical in the Amplifone HV board. You MUST use a BU406D, a regular BU406 does not have the internal dampening diode or internal resistor, and using one of the BU406's can kill your HV transformer. I've heard of using a external diode on a regular BU406, and heard that this can work, but I prefer using a tested good BU406D. Just be sure you are getting BU406D's and not BU406's. I'd order at least 3 these at a time.

BU406D (produced by SGS)
1-11 @ $1.89
12-> @ $1.59
Computer Component Source
1-800-356-1227
FAX 1-800-926-2026
EMail orders@ccs-sales.com

Richardsone Electronics www.rell.com (Rodger posted info about them supplying CRT's) also sell the BU-406D. They are only $1.90 up to quantities of 100.
http://catalog.rell.com/rellecom/scripts/SkuPage.asp?SKU=10677

Thanks to David Shoemaker and Jess Askey for sourcing the BU406D's, I ordered these a while back, and wasn't sure where I got them from.

A good BU406D should test as follows using diode test on your DMM:

Looking at the BU406D from the front, pin one is the base, pin 2 is the collector, pin 3 is the emitter. Test using diode test (you CAN'T test a BU406D on HFE). In the chart listed below, Red (positive on your meter) goes to the first pin, black (negative on your meter) goes to the second. The heatsink tab on the transistor is also the collector, so if your second pin is allready clipped, just use the tab.

Base to collector = Junction drop (between .470 and .690v)
Base to emitter = reads a short, or about .020v (YES, A SHORT. This is correct, remeber the internal dampening diode and resistor??)
Collector to base = Infinity or open curcuit
Collector to emitter = Infinity

Emitter to collector = Junction drop
Emitter to base = Short

While we're on the BU406D, you will want to make sure the collector heatsink is securely soldered to the board, and that you are getting good continuity from where the collector of BU406D connects from the heatsink to the board. THE BU406D DOES NOT GET INSULATED to the heatsink, the heatsink is actually the collector connection. When tightening the screw for the BU406D, use the same tension that you did on the +/-24v regulators. It has to be tight enough to make good contact. You will have to clip the collector pin (pin 2) to install the BU406D to the board if it hasn't been done allready.

MPSU07 (Q3 on schematic)

These transistors seem to be pretty reliable according to the HV boards that I have seen. However, you will want to pull and test it while your working on the board. If it's bad, it can damage other components. It should test like any normal NPN, you can use HFE on this one, or diode test. If you need a replacement, an original MPSU07 can be hard to find. I use SK3199 (available from Mouser for around $2.50) as it is rated over spec to the MPSU07.

MCI "the red mystery can"

Well, thanks to Zonn, the "mystery can" is no longer a mystery. I am putting Zonn's explanation here:

It seems fairly apparent that the HV section of the Amplifone is regulated much like that of the old (and maybe some new) constant voltage AC supplies that use ferro-resonant transformers.

Basically the idea is that a transformer can only be driven to a maximum voltage, after which it saturates and an increase in input voltage does not correspond (nearly as much) to an increase in output voltage. This maximum voltage, before saturation, is highly dependent upon the resonance frequency of the transformer.

The constant voltage AC regulators use a capacitor to tune a winding of an isolation transformer to 60hz, causing the transforming to go into saturation. After which voltages of around 70v to 140v input has little effect on the output, and changes in current loading also have a much smaller effect. Pretty cool.

If you look at the schematic of the Amplifone HV you will see no feedback from the output voltage, back into any sort of regulator. In fact the Amplifone contains no HV regulation circuit of any kind! (With the exception of the over voltage regulator, see the following note.)
The 555 is simply set to a frequency, which drives (unregulated) the Q1/Q2 amplifiers, which drive the primary of the current boost transformer T1, which drives Q3, also with no regulation!

I have no way of knowing exactly what's inside MC1, but the only way for this circuit to regulate it's output voltage, given changing output currents, would be for some type of ferro-resonant regulation to be taking place. MC1 must be a type of tuning coil, possibly a coil and capacitor, that along with the inductance of T2 is used to set the resonant frequency of a ferro-resonant regulator. (Which is probably why T2 is so expensive and hard for other companies re-engineer.)

These companies are probably winding the HV to give the proper increase in voltage, but not taking into account it's inductance and Q ratings, which in most HVTs are not nearly as critical. As a result, when it

comes time to test the transformer in the circuit, they fail at regulating the output voltage. Just a guess mind you, I wonder if anyone could verify this?) MC1 combined with T2 must form a resonant circuit. As the 555 is brought closer/farther from the resonant frequency of MC1/T2 the voltage coming out is higher/lower.

Thanks, Zonn! Now that damn red can is starting to make some sense.

I know that these can fail, and when you've got a bad one, it can blow +/- 24v regulators like crazy as well as preciuos BU406D's. I've seen two boards that were blowing +/- 24 regs as well as BU406D's, and discovered that the 5w 50 ohm resistor near the +24 reg had burned the side of the MCI can. For the life of me I couldn't figure out why I was killing regs and BU406D's. I replaced the MCI with one I got from another HV board (this one wasn't burnt), and everything worked. I know of no place to source these. If you do, let me know. Watch the placement of your 5w 50 ohm resistors so they are not too close to the MCI.

Brown Jumpers

These damn things should be taken off of the board, and replaced with a small piece of heavy solid wire. There is only one on the HV board, it is labled W2, and is located right next to C2. You may want to stomp on this jumper after you pull it out. These jumpers have caused countless headaches. They often go dead, and can cause you to waste alot of time trying to find your problem. There are a bunch of them on the Amplifone deflection board, but that will be in the Amplifone Deflection guide.....

Mounting a Fan

In my opinion, a fan is a necessity in the cabinet when using an Amplifone monitor. I use a 120v AC fan. I tap the 120v AC line that goes to the marquise light, and mount the fan so it blows directly on the HV board, and try to aim it at the HV transformer. By using your 120v AC to the MQ light, you're not straining your audio reg by tapping any DC current.. This will do wonders for the life of many components on your HV board. I use a fan that is no bigger than 100x80 or so millimeters, and it should produce between 22-50 CFM. Make sure you use the ground wire (green in your 3 wires to the MQ light assembly). I attatch the ground to the case of the fan. Try to use a fan that runs smoothly and quietly, you don't want a ton of vibration in the cabinet. I recommend the one listed here:
http://www.web-tronics.com/webtronics/csa8038ac.html
They are $15.26 each.

HV Transformer

History

Now for the part you've all been waiting for. The famous saying "Red is Dead, Black is Bulletproof". The part of the Amplifone monitor that can partially be blamed for the downfall of all Vector arcade machines. The part that causes many people to wonder why you would bother restoring these Amplifone monitors in the first place. I'm going to put a bit (well, a bunch) of history here. I feel a component as infamous as the red Amplifone HV transformer warrants it. I'm allways looking for more information on the historical side of things, so if you know any more info, or, if anything needs corrected, please let me know.

If you have no interest in this, you can skip this section and move to the "Red is Dead" section that follows.

Much of this information comes from 2nd sources, so I can't say that it is 100% acurate, but it seems to make alot of sense. I was lucky enough to correspond with Carl Newman, a friend of Frank Ballouz (former Atari VP in the coin-op division) and Jack Hammond, a former employee at Amplifone in Brownsville TX.

Amplifone was a company that made various electrical and electronic components, and was located in Brownsville, Texas. This is about the southernmost part of Texas, right near the Mexican border. Before making the Amplifone Vector monitor, they made things as simple as coils for solenoids in electric bells, and complex as radar systems used in the U.S. millitary.

Here lies the connection to Atari: Rumor has it that while Ed Rotberg was working on the Army version Battlezone, he was forced to work with engineers from Amplifone that designed radar assemblies for the millitary.

The company apparently knew alot about radar, but nothing at all about arcade machines. Much of Rotberg's displeasure with the Army Battlezone project was having to deal with the Amplifone/millitary engineers. Ed was used to working with brilliant and creative minds at Atari like Lyle Rains, Dave Theurer, and Ed Logg. He hated being around the stuffy ex-millitary Amplifone guys who were 30 years older than he was. They had no interests similar to his. Ed was stuck, with no way out, and almost quit over this.

However, Ray Kassar (Atari Chairman) saw the Army Battlezone project as a great way to give Atari a ton of credibility, and free publicity. During Ed Rotberg's time at Amplifone, Ed suggested to Frank Ballouz (VP in the coin-op division) that Amplifone could be a possible supplier of X/Y monitors for Atari arcade machines. Atari was having big trouble meeting demand from Wells Gardner for WG6100 color Vector monitors in 1981.

Tempest had a big production run going at this time; it was the ONLY arcade machine in history that completely sold out the first 20,000 units before they were produced. All orders were prepaid. The only thing holding future sales up was the fact that they could not receive monitors fast enough from WG to meet the demand. Thousands of Tempest cabinets were built and sitting in the warehouse without monitors. The situation was critical. When you consider that Atari had another pretty hot color Vector game known as Space Duel ready to roll, the monitor situation was even more intense.

Frank Ballouz checked out the Amplifone building and saw that they would be very capable of supplying monitors to meet the demand that WG couldn't. He suggested to Ray Kassar that Atari contract Amplifone to produce color Vector monitors. Instead of giving Amplifone a contract, Ray decided to buy them out. Steve Ross (owner of Warner Communications) gave the nod, and just like that, in the spirit of true vertical integration, Atari owned Amplifone. According to Jack Hammond the entire process took less than one week. "Frank was here on a Thursday, and Atari bought the company by Tuesday the following week." Atari had a TON of muscle at this time. This was about 2 years before the crash, and you might say Atari was at its peak power in both the coin-op and home vid market. Buying Amplifone for Atari was like your average arcade phreak dropping a quarter into a machine.

Here is where the story on the Amplifone Color X/Y monitor becomes clouded. Apparently, the design for the Amplifone Color X/Y came from Atari, and I think it would have been patented, but I haven't found any of these patents yet. If anybody has more info on this, please let me know. The design was a fantastic one for its time. The deflection board is much more reliable than those found in the WG 6100, and the HV board was also designed fairly well. As you are probably aware, though, the HV board had a problem. I feel that this problem was a major factor in the eventual downfall of all Vector games in the arcades.

The "evil seed" in the production of the monitor came from the maufacturing of the HV transformer. A HV transformer must be manufactured under ideal conditions - it must be dry, with very low to no humidity. The temperature must be consistant (preferably around 70-90f degrees) to prevent condensation. A clean room is not a necessity, but the air should be relatively free of any foriegn particles (smoke, dust, etc..)

Many of the "know nothing" Atari exec VP's at this time enjoyed traveling to different Atari locations, looking at things they knew little or nothing about, while throwing their weight around. Rumor has it that a group of Atari big wheels came into the Amplifone plant in late 1982 for a "visit and inspection" before taking a much needed (ha!) retreat to Corpus Christie, TX.

With this group was a person who would eventually become president of the entire consumer electronics division. I am refraining from using this individuals name. Though my case is strong enough to win a possible defamation lawsuit, I don't have time for the hassle. This individual (in my opinion, as well as many others) is one of the people who can get a great deal of the blame for the entire downfall of Atari. If I write a book someday, I'll elaborate further than in this faq. Beware. He was hired by Ray Kassar from Jovan, a

perfume company. He later became president of the consumer electronics division. He was imediately fired after Warner stock dropped 40 points in one day, but he did plenty of damage before this. I will refer to him as Mr. P.O. from here on.

Apparently, while touring the plant in 1982, Mr. P.O. couldn't understand why he was told not to smoke in the building, and even had a technician fired for telling him to put out his cigarette and to "please smoke outside the building." He also couldn't understand why it was so uncomfortable in the building. He was amused by the winding room, and liked to watch the machine wind the wire on the HV transformer spools. "He thought it looked like a big sewing machine..."

Somehow(?!), during Mr. P.O.'s vist, a cigarette ends up in a garbage can at the Amplifone warehouse. This was where the big spools of wire were kept until they were needed to wind the HV transformers in the winding room. The garbage can catches fire, and the buildings' sprinkler system comes on. The spools get soaked. Wanna guess what happened next??

The Amplifone employees are irate. Several are ready to kill Mr. P.O.. Mr. P.O. orders them to "clean this mess up, and get the machines running, unless you want to loose your job! We've got deadlines to meet!...."

I'm willing to bet that these spools that got soaked were used in the production of MANY Amplifone HV transformers. Though the wire is insulated, the moisture that the wire was exposed to became trapped in the coil in the HV Transformer. After the HV transformers were used for a length of time, the moisture caused the insulation on the HV wire to break down. When this happens, the HV transformer no longer works.

Red is Dead

Please register your HV board serial #'s with red HVT's on GameArchive:
http://www.gamearchive.com/cgi-bin/amplifone/serials.cgi

Most of the HV transformers that die are red. Breaks in the insulation can occur in either the primary or secondary winding, and there is no "common" failure amongst the red HVT's. When the spools got wet from the warehouse trash can fire at Amplifone, there was no way to predict when or exactly where the insulation in the red HVT's would break.

Some people (myself included) have reds that work great to this day. I've been observing serial #'s of these. It seems that some of the very early ones can be fine (serial #'s under 800 or so, you'll see the number on the heatsink bar "XY No. _____") Some of the very late ones can be fine (above 17000) as well. Perhaps this indicates the ones before 800 or so and after 17,000 were not made from the soaked spools? I've also seen ones within the "Danger Zone" on serial #'s work, but I think the odds are against these being good. If they do work, they don't seem to last very long.

Jess Askey has been kind enough to put a serial # registry for HV boards with red HVT's on the GameArchive. Please register your boards serial numbers here, and please test your HVT's before registering them.

http://www.gamearchive.com/cgi-bin/amplifone/serials.cgi

Perhaps we can narrow the serial #'s down to determine which reds might be good or bad.

In any case, you CAN NOT count on a red HVT, regardless of the serial #. If you find one that seems OK (see "Testing your HVT") you may choose to use it until it quits. Be aware that when the HVT goes, you WILL also loose your BU406D, you have a good chance of losing your +/- 24v regs, as well as some of your diodes. One diode that has a chance of blowing when the HVT goes is CR3, the 1500v diode right behind the HVT. This diode is not very easy to find, and it's not cheap. If you find a good source, please let me know. I plan on putting a "Sourcing" section to this guide later that will show the best places to get parts for Amplifone HV boards.

Another risk you run with a red HVT is that of fire (ask anybody who runs a G08!). You do not want to have one of these burn in your prized Major Havok, Quantum, or Star Wars cabinet. I've only seen one go out flamming, but have heard of several other people who have as well.. The one I saw was in a SW UR, around early 1984. The inside of the cabinet was seriously burned, and the heat was great enough to warp

the plastic housing around the monitor. If your cabinet is in great cosmetic shape, DON'T risk using a red HVT.

Black is Bulletproof

After the red HVT fiasco, Atari commissioned Penn Trans of Bellefonte, PA to make a replacement. Some of these may be a rare find as NOS through some Atari parts distributors. (You've got VERY slim odds on this, but it may be worth trying in your area). These look alot different than the original reds. They are black, a bit smaller than the reds, and do not use connections from pins on the base of the HVT to the board. The Penn Trans HVT has 6 wires that come out near the base facing away from the focus assembly. They go through the 2nd hole in the board, right next to the BU406D.

The Penn Trans HVT's are labled Penn Trans, and have an address listed as Wingate, PA.. These are the first black replacements, and were built way overspec to the original reds. If you find a HV board with one of these HVT's, you have good odds that the HVT is fine. These were all installed to replace reds, as far as I know, no blacks were manufactured stock. I've only heard of one failing over the past 10 years. There are rumors of people finding these from some distributors (Betson, Atlas, etc..) for low prices. I know of one friend who bought 4 for $100 about 9 years ago. The part number is 926862802, replacement for Atari part #A201005. If you find these cheaper than $100 each, you may want to buy them.

WinTron HVT's - http://wintrontech.com phone: (814) 625-2720

The common replacement for the red today is the WinTron tranformer / multiplier. WinTron is Penn Trans, they just changed their name after the company changed hands. Their part number is still 926862802. These things are not cheap, right now $190 a pop, and no quantity discount that I'm aware of. This is expensive. However, these are put together VERY well, and are supposed to be even superior to the PennTrans HVT's. They carry a one year warranty. They are pretty similar to the PennTrans HVT's in appearance.

You will have to make some minor changes to your HV board to accomodate the WinTron. After removing your red, you'll want to drill the mounting holes out to 3/8", they are a bit to small as stock to fit the bolt size and 6 wires on the WinTron. When you remove your red, you'll want to make note of the gray wire coming from the base of the red HVT. On the beige/green board, this goes to a location labled "WHT", and on the blue, it is labled "HTR WHT". The mounting nuts that went to the bolts on the red are too small to work on the WinTron (or a PennTrans) mounting bolt. You'll have to find one that works, the WinTron is not shipped with one. (You'd figure for $190 they could put one on....)

If you're mounting the WinTron HVT to an early Blue or Beige board (empty slot at R18, to make things easy) you'll want to move the 3 black ground wires to a different location to allow the WinTron HVT to sit comfortably in it's socket. I usually mount these at the lower right corner of the board (oriented with the focus assembly on top and the heatsink bar at the left. I simply drill 3 very small holes in the ground trace on the lower right of the board, and use a small jewelers file to scrape the insulation off of the solder side of the board where the holes are. Now, you can solder the 3 black ground wires to the board at their new location (this is actually where they appear on the newer beige and green boards) and the WinTron HVT can sit in it's spot without being on top of the ground wires.

Once you get the WinTron HVT secured to the board, you'll want to solder it's wires into place. I'm going to explain this so that you can visualize their locations in relation to a clock. The WinTron instructions can get a bit confusing, so this may help out. Hold the board solder side up with the focus assembly at the top. We're going to look at the solder spots from left to right, reading them clockwise. There are spots at 7:00, 8:00, 11:00, 1:00, 2:00, 4:00, and 5:00. The final spot used for the gray wire is labled "WHT" on the newer beige & green boards, and "HTR WHT" on the early blue and beige (empty spot at loacation R18). This is the spot where the gray wire was from the old HVT. You'll want to run the wires through the 2nd hole in the board just behind the HVT, and solder them as follows:

7:00 = orange
8:00 = no connection
9:00 = green

1:00 or 2:00 = black
4:00 = yellow
5:00 = red
"HTR WHT" or "WHT" = gray

Testing your HVT

I'm going to start this section with a suggestion : Get a Bob Parker/Dick Smith LOPT tester. They are available from John's Jukes. Here is the address:

http://www.flippers.com/fbt-main.html

They are defiantely worth the money, (I think about $45 now) and if you work on monitors fairly often, you'll love having one. John also stocks a nice ESR meter for testing capacitors in curcuit in monitors, both Vector and raster. I have one and it is great, you may want to order one when getting your LOPT testser. Using the LOPT, I put the red lead to the 7:00 pin (orientation as mentioned above) and the black lead to the 5:00 pin. A good ring is anywhere in the green on the meter, though I've seen plenty of good HVT's ring in the yellow range. If you're seeing a red light, time to call WinTron, or try John Robertson's Amplifone HV hack using a Wells Garner HVT. The hack is posted on John's website: http://www.flippers.com/vid-tips.html . John's hack works, though you're going to have to find a way to fit another chasis in the cabinet.

You'll want to ring your HVT using the LOPT meter as follows:

red @ 7:00, black @ 5:00 (as mentioned above)
red @ 9:00, black @ 5:00
red @ 7:00, black @ 4:00
red @ 9:00, black @ 4:00

If you're testing a PennTrans or WinTron, you're likely to see yellow rings becuase of the dampening diodes in the HVT. At best, these will ring on the low green level.

Adjusting your HV (R7 & R17)

One thing to remeber when you've installed the WinTron - The WinTron HVT has been built WAY over spec to the original. There are several dampening diodes, and you may not be able to adjust your HV overvoltage "by the book" if you are following the Amplifone manual. This can be found at the GameArcive: http://www.gamearchive.com/video/manufacturer/atari/vector/html/monitor.html
The "book" says to hook up your HV probe, apply power to display, and rotate R17 fully counterclockwise. Then, it says to rotate R7 (frequency) until you get a reading of +25kv. Rotate R17 VERY SLOWLY until the HV cutoff kicks in, and your HV drops to 0 on the meter. Turn the power off for 5 seconds to reset the HV overvoltage curcuit. Readjust the frequency (R7) until your meter reads 19.5kv. Remove power from the display, and remove the HV probe.

The key thing to remember here is that chances are your WinTron HVT will not allow the HV to shoot to 25kv because of its superior design. What I usually do is set the HV overvoltage R17 to its center position and then simply adjust the frequency (R7) to get an acurate 19.5kv. The following posting comes from Mark Jennison, he is refering to adjusting the HV on a Penn Trans HVT:

I thought I'd post a follow up to the HV over-voltage problem I had. Last time
I told you that I simply cranked the pots to their extremes, and it came up.

Well, this weekend while working on the deflection board, that little trick didn't work any longer :-(. Anyway, here's how I fixed it. You may want to bring up
http://www.gamearchive.com/video/manufacturer/atari/vector/monitors/amplifone/amplifone_hv_adjust.gif as a reference.

Now, the first thing they say you should do is verify the +24VDC and -24VDC on the board. Well, the values were pretty close, so I figured they were ok. However, as I didn't realize, the voltages are only valid if the transistors are under a load of some kind. But since my HV was always being shut off by the overvoltage circuitry, there was no load on the regulators.

I finally decided to disable the HV overvoltage circuitry.

>>>>>>>>>>>>>>CAUTION!!!!!<<<<<<<<<<<<<<<<<<<<
DO NOT disable your HV overvoltage curcuitry unless you know exactly what you're doing! In an overvoltage state, the picture tube can emit X-rays that can be harmfull. You may want to just try changing the value of R6 (as Mark has kindly listed below) instead of disabling your HV overvoltage by taking CR1 out of curcuit. Thanks to John Robertson for pointing out the potential hazard.
>>>>>>>>>>>>>>>>>>>><<<<<<<<<<<<<<<<<<<<<<<<<<

This can be done by lifting the leg of diode CR1 (1N914) by R7. I put the HV probe on under the anode cup (with the ground lead of the HV probe connected to the DAG) and fired up the game. The HV was around 27KV, so I assumed the HV overvoltage circuit was indeed working correctly. There was a picture, but I had to turn down the screen adjustment to keep from burning the tube.

Now that the HV was actually running, I could take some readings of the voltage regulators. -24VDC was only about -12VDC. The large 5W resistor across the input and output had actually been doing the work instead of the regulator. Replacing the -24VDC regulator brought the HV down to 25KV, but it was still too high for the overvoltage protection circuitry.

After verifying the rest of the devices in the circuit, I could not figure out what was wrong. I took another look at the schematics and figured out how the 555 timer was used as some sort of loop back circuit which stepped up the HV. Everything in the circuit checked out, so I finally decided just to modify the circuit.

A simple way to increase or decrease the KV was to change the value of R6 (3.9K ohm resistor). Putting in more resistance increases the KV, while decreasing the value decreases the voltage. I replace mine with a 2K ohm resistor, and rechecked the HV, which was now around 20KV.

I reconnected the HV overvoltage protection circuitry and the LED was off (yay!). Resoldering the CR1 diode brought the KV down a little (for some reason), but I was able to adjust it back up with R7 (frequency adjust). I was then able to set the HV over-voltage (R17) correctly.

So that was it. Maybe there's a few tips in here that Gregg Woodcock can put in his FAQ (Pull up a leg of CR1 to disable HV overvoltage circuitry, change R6 to increase/decrease HV, whatever...)

Mark Jenison E-mail address: jenison@cig.mot.com
Cellular Infrastructure Group Motorola--Arlington Heights, IL

Thanks Mark! Keep in mind, he is refering to a Penn Trans HVT. Odds are if you're using the WinTron, you might not see this problem, but it is important to keep in mind if you feel everything is fine on your board and you're still getting no HV. Again, DO NOT disable your HV overvoltage protection unless you really know what you are doing. You might want to try using a Variac to gradually power up the monitor (Thanks John Robertson!) to prevent possible X-ray emissions.

Step by Step to repair your Amplifone HV board

I guess this section should have appeared first, but I felt it was more important to discuss the components, boards, and their differences before the repair guide. Joe Welser deserves alot of credit here, he was the first to create a guide of any kind. Some may choose to just read this section and ignore the previous ramblings.

First, remebering my Randy Fromm lessons, GARBAGE IN = GARBAGE OUT. Before doing any work to the HV board, you will want to verify that your deflection board is producing the +/- 30v (this can vary from +30 to +39, and from -30 to -39vdc) Check this at J103, and you'll be looking at pins 6, 7, and 8. Pin 6 is ground, pin 7 is -30 to -39, and pin 8 is +30 to +39. Remeber that this is an unregulated voltage, it may swing a bit as you test it. You will also want to check this voltage on both the + and - side for excessive AC ripple. If you're seeing ripple over .2v, you may want to replace the big caps (4700uf @50v, c17 &c18) on the deflection board. If you see no +/-30v at J103, check the fuses and their f3 and f4 (5A 250v SB) on the deflection board, followed by the rectifier diodes (CR 14, 15, 16, 17). These diodes can often develop cold solder joints, so make sure they are soldered properly. I'm going to cover more on the Amplifone deflection board when I eventually do a faq, stay tuned.

All of the steps below are to be done with the HV board removed from the machine, and with no power applied.

Step 1: Check your HV transformer

I use a Dick Smith LOPT tester (as mentioned before in "Testing your HVT") and test the HVT in curcuit. (NOT with the power connected to the board, but with the HVT still soldered to the board - I got worried somebody might actually try ringing their HVT with the power on! - Remember what I said about damaging yourself as well as your equipment??) If your HVT is ringing properly you can feel lucky and move to step 2. If you are getting "marginal" rings (low yellows), you may want to pull the HVT off of the board and test it.

NOTE!!>>>> Keep in mind that it is normal for a red HVT to ring alot higher than a WinTron or PenTrans, whether it is in or out of curcuit.

Pulling the HVT from the board is best done by using a soldapult to get the solder out of the pins, then gradually heat and pull the HVT off, applying heat to the stuck pins. Be careful removing the HVT, I've seen a few boards cracked from trying to pull the HVT out before all the pins are loose. Then, use the LOPT to test again, and see if you're marginal ratings are better.

If your HVT is ringing bad, save your quarters, and call WinTron, or get a WG chasis and use John Robertson's HV hack. John's website: http://www.flippers.com/vid-tips.html
WinTron : (814) 625-2720, part #926862802; WinTron website: http://www.wintrontech.com

Step 2: Pull and test your BU406D (Q2 on schematic)

A good BU406D should test according to the chart listed in the BU406D section of this faq. Remember, when the HVT goes, it WILL take the BU406D with it 99% of the time. Leave the BU406D out before going to step 3, you won't want it in until you are allmost done with these steps. If your BU406D is testing bad, you'll have to replace it.

Step 3: Pull and test your MPSU07 (Q3), both 3904's (Q1 and Q5), and the .8amp 100v SCR (Q4)

The 3904's are easy enough to get, and testing them is fairly easy using either Diode test or HFE on your DMM. If your BU406D or MPSU07 is bad, they can often take the 3904's with them. If you need to replace the MPSU07, you can use an SK3199 as shown in the MPSU07 section of this faq. Testing the SCR (Q4) is easy enough, just pull it and test on diode test. If you are reading an open curcuit or short in any direction, you'll have to get another. They are relatively inexpensive and not very hard to find. I didn't include a section on Q4 becuase I don't think I've seen one go bad yet.

Step 4: Test all resitors and diodes

Testing the resistors is simple enough, they can be done in curcuit and should be within 10% of their specified values. To test the diodes, I simply pull one lead out of curcuit and use diode test. Most all of the diodes and resistors should be easy to replace if you find any that are bad. The only tricky diode is the large one (1500v) right near the HVT; it is labled CR3. This can be hard to find, let me know if you have a good source.

Step 5: Reccap the board

I reccap using 105 degree low ESR caps as listed in the "Common Electrolytic Capacitor Changes" section. See the table for the values that I reccomend.Be sure C3 and C4 are not too close to the 5w 50 ohm resistors at the regs (if your board has them). The heat from the resistors can damage the caps, as well as the +/- 24v regulators and the red MCI "mystery can".

Step 6: Check for good +/- 24v

You'll want to test the 7824 and 7924 to see that you are getting a good +/- 24v. Remeber that you should check the insulator (and replace it if it's the "rubber" type) on the 7924 (VR2) before applying the power. I use a mica T0220 insulator and silicone heat sink compound.
As long as the BU406D is out, this is relatively safe. With the BU406D out of curcuit there is no chance of any HV being generated. This test is done with the HVT wired to the deflection board. Plug in your harness to J103 on the deflection board (right next to the rectifier diodesand just in front of the big caps). Connect your DAG ground to the deflection board (from the tube spring). You don't have to connect the yoke plug (j105), the neck connector (j101), or the HV anode. I use microclips to the leads of the regs to test the voltage. Put the red lead to the output of the 7824 (+24v) (pin 3) and the black lead to ground (pin 2). The 7924 (-24v) uses pin 1 as ground and pin 3 as the output. The lower back ledge (where your back door rests when it is on of your machine) makes a decent test area, you can put the heatsink on top of the panel where the power switch is mounted, so the the HV board stands up with the solder side facing you. Your harness should have no trouble reaching the HV board when it sits here.

Your +24 should be anywhere from +24 to +27.5vdc, and your -24 can be as low as -36v if your board has the 5w 50 ohm resistors at the regs. If you are missing either +/- 24, I suggest using the 7824cv & 7924cv as

a replacement - see the 24v regulator section of the faq. Don't panic if your readings are not exactly +/- 24. The 5w 50 ohm resistors can make your readings a bit wacky when there is no load on the regs.

Step 7: Check for a waveform at the base of the BU406D

You'll need an oscilliscope to see this. Put the red lead to where the base of Q2 goes (on the solder side), and put the black lead to ground. The parts side shows what pin would be for the base. AGAIN, we are doing this with the BU406D out of curcuit. You should see a nice 20khz waveform. If you don't, you'll want to start checking all components in the oscillator curcuit, including the 555 timer(U1). A bad R7 (2k pot) or R17 (20k pot) can cause wierd things in the oscillator curcuit. You may want to clean or replace these pots if everything in the oscillator curcuit is OK and you're still gettng problems seeing a good waveform at the base of the BU406D. The 555 should produce a small waveform at pin 3 of the chip. You can use your scope to trace through the curcuit and see where the waveform is being lost. You may want to recheck Q1 and Q3 if your oscillator curcuit seems OK, but you still get no waveform at the base of your BU406D.

Step 8: Add 5w 50 ohm resistors and 1N4001 diodes at +/-24v regulators

As mentioned before in the previous section, you'll want to allways add the diodes to your board if they aren't there. Make sure the leads are well insulated if your 1N4001's are on the solder side, as stated earlier in the faq. Unless you are using the board in a Quantum only, you'll also be adding the resistors. Be careful in placing the resistors, they do get hot and can damage nearby components.

Step 9: Put the BU406D back in curcuit

Aside from securely soldering the BU406D, you want to remeber that you do not insulate the transistor to the heatsink. You may also want to take this time to verify your wiring harness, and make sure your continuity is good all around. Don't forget to check the DAG ground, too.

Step 10: Adjust the high voltage

Now you are ready to try out your HV boad. Follow the section labled "Adjusting your HV" and be sure to read Mark's post. Remember, if you're using a WinTron, the internal protection in the HVT may prevent it from going to 25kv.

Step 11: Install a fan

You'll want to install a fan after you get your HV board working properly and have it adjusted. This will make life alot easier for your HVT, the BU406D, and your +/- 24v regulators.

Problems & Solutions----------

Q> Why am I not getting +/- 24v from the regulators? The board is dead! I replaced the regulators, but I'm getting nothing...

Check the stupid, assinine, and idiotic brown jumper located right next to C2. GET RID OF IT. See section on brown jumpers in the faq. I've seen ones test fine. Then they decide to quit just as power is applied to

the board for the first time in 15 years. You're thinking "I tested that jumper, right before replacing the +/-24v regs, and it was fine...It can't be that..."

Also, check your +/- input voltage from J103 on the deflection board to be sure you're getting the +/- 30v. You may also want to double check your harness.

Q> I'm continuously losing BU406D's. My HVT is ringing fine on the tester. My +/- 24v is OK. My MPSU07 is fine. I get no HV, and the BU406D is dying after power is applied to the board.

Make sure you have good continuity between the collector heat sink, and the collector of the transistor itself. Check to see that the heatsink is securely soldered in place, and that it is conducting. Make sure you still have a waveform at the base of the BU406D. If you're missing your waveform (or seeing a line that is almost flat), recheck your 555 oscillator curcuit. A "flat line" on the scope can easily kill your BU406D. If your oscillator curcuit is fine, and you have a waveform at the base of the BU406D, you may have a marginal failure in the HVT. It might still ring OK, but if you see "pulsing" in the rings, this can be killing your BU406D. Time to call WinTron, or get John's 6100 WG>HV hack.

I've never seen a modern WinTron fail, but there is allways a first. Remeber to save your WinTron papers, their HVT carries a 1 year warranty, and they are very good about taking care of their customers.

Q> I'm losing +24 and -24v regs, sometimes they even blow apart! Both regs are insulated, my HVT rings fine.

Make sure that your red MCI can is clear of the 5w 50 ohm resistor near the MCI case. Inspect the MCI case for cracks and burns. Try replacing the MCI (if you have a spare). Check the Zener Diode 1N754A in the overvoltage curcuit and replace it if necessary. Also, check the R17 20k over voltage pot, and replace as necessary.

I wrote this faq to help fellow Amplifoners out. I'll do my best to help you if you're having troubles as my schedule permits. Please try to understand, though, I work 3 jobs. (Why do you think it took me so long to write this thing?) My e-mail address is mkdud@aol.com .

Please try to read through the faq to determine your problem. I think I've covered every problem I've seen with the HV board in the faq. If you have anything to add, please let me know!! I'm allways up for comments and suggestions, and would allways like to hear more info on the historical side of things as far as Atari goes. Some day, I'd like to write a book about the Atari coin-op division.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>><<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<