How to Bring Up a 6100 Color Vector Monitor

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Congratulations! You've managed to acquire all of the parts for a Wells Gardner 6100 color vector monitor. You are well on your way to enjoying true vector greatness. Whether you sourced the parts individually, or had the boards sent out for repair, it's time to put everything together and see those beautiful vectors. This guide will walk you through the major steps to bring the boards up and get your monitor running, while minimizing the potential for a lot of common problems (many of which I've learned the hard way, which is how this document initially came to be).

Step 0: Intro, warnings, and advice

First and foremost, you definitely don't want to go cowboy style and fire up an unknown 6100 all at once. The chances of Bad Things happening are significant, as even with known working boards, things can happen during installation that can cause problems, and many problems can cascade, and do a lot of damage across the entire monitor. The best strategy is to bring it up in stages, piece by piece, to minimize and contain damage, to prevent the ripple effect if there are issues during the process.

The steps in this guide are specifically designed to maximize safety and minimize damage, if there are issues. The tradeoff is that the procedure is lengthy, and might seem redundant in places. However every step intentionally included to catch a potential problem that I personally have run into at least once. It is recommended that you follow all of the steps as closely and patiently as possible, if you want to maximize your chance of success.

Also (and this probably actually should have come first), this guide assumes you are aware of the electrical hazards of working with monitors. If you are not familiar, go read up on them. I learned the basics from Sam Goldwasser's amazing repairfaq.org (which if you are not familiar, is a mind-blowing resource comprising literally thousands of pages of repair and electronics info, and is as old as the web itself). Here is one link to some basic monitor safety info, but I would encourage you to read up on all of the monitor info on his site (which includes some vector stuff as well, though you'll have to dig to find it):

http://www.repairfaq.org/sam/monfaq.htm#monsaf

One of the best pieces of advice I can give you up front is to treat these boards, and especially the wires, as if they were made of glass. This is true of all of the boards and wiring in your 6100, as the boards were not very robustly made, and the wires break VERY easily. It is common for wires on the neck board, deflection board, and also where the wires connect to the frame transistor sockets to break when you are simply installing any of the boards in a 6100.

Also, many of the parts that stick up from the deflection board are fragile (e.g., the metal heatsinks, power resistors, and large filter caps), as any excess force on them can easily crack the solder joints and/or traces beneath them. It is very important to treat them VERY gently, and not put pressure on these parts.

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Also, AND THIS IS ONE OF THE MOST IMPORTANT THINGS IN THIS WRITEUP, always, always, always be aware of the neck of the tube when working inside the back of the monitor. Not for electrical reasons (as the monitor should normally be off if your hands are in there), but because of tube damage.

The NUMBER ONE way people crack the necks of 6100 tubes is when removing connectors from the HV and deflection boards. They pull hard, without realizing where their hand is, and when the connector pops off, their hand jerks back with it, whacks the neck, cracks it, and releases the vacuum. Poof. And once you hear the hiss of death, you've turned your 6100 into a 40-lb paperweight, as there's no practical way to repair a tube. (And a replacement used tube, if you can even find one, will run you on the order of $300-400, at the time of this writing).

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Pro tip: I often remove the neck board when I have my hands in the back of the monitor, just to get more room, and decrease leverage, as hitting the neck board will often put more stress on the neck, versus hitting the neck directly (which is also less likely to happen to begin with, if you have more room to work.) You don't need to remove any of the wires, just pull the neck board off of the neck and let it hang, out of the way.

Be aware that this document is not meant to cover all aspects of 6100 monitors. This list focuses on the practical aspects of bringing the monitor up, assuming all of the parts (boards, tube, yoke, etc) are generally working. It does not go into the details of troubleshooting or repairing bad boards, or other issues surrounding various modes of 6100 failure. It also assumes the yoke is mounted on the tube already, and doesn't go into details of purity and convergence adjustments, or color drive and bias controls, as those procedures are already described in the 6100 manual. For more debugging and repair info, refer to the 6100 manual and FAQ, at the links below.

(Also, be aware that there are earlier versions of both of these docs on the web. These are the most recent, so it's always best to check which ones you have.)

6100 Manual and Schematics (Atari TM-183, 3rd Printing):
http://arcarc.xmission.com/PDF_Monitors/Atari%20Monitor%20TM-183%203rd%20Printing%20WG%206100%20XY%20Quadrascan%20.pdf

Color Vector FAQ, v1.1:
http://www.ionpool.net/arcade/tech/6100_faq.pdf

Also, one more related resource (which is geared more toward the repair side of things), Bill Boucher (a.k.a., Biltronix) has compiled an EXCELLENT list of parts info for 6100s, including substitute and upgraded parts for some hard-to-find components, with Digikey part numbers, and links. Be sure to consult his pages for any and all 6100 parts-related questions:

http://www.biltronix.com/arcade_electcomp_04.html (6100 parts)

http://www.biltronix.com/arcade_electcomp_01.html (other parts lists + info)

So, let's get started...

Step 1: Test the game board

The first step before even touching the monitor is to make sure your game board is putting out valid and safe signals. Hooking a 100% working 6100 up to a game board that is misbehaving can very easily damage the monitor. Also, just because the game board is playing blind, that doesn't mean the output voltages are ok, as it's possible to have issues in the analog output section of vector game boards, which will still allow the board to play, but still send excessively large signals to the monitor, which can easily damage it.

To test your game board's output, measure the DC and AC values on the XOUT and YOUT test points (located near the video adjustment pots), with the monitor unplugged.

The DC voltage should be between 0 and 1 volt roughly, and AC should be around 2 to 3 volts, for both XOUT and YOUT. Note both of the DC and AC values will fluctuate as the game goes through attract mode, so these are approximate values. But if you're seeing more than a volt of DC, or 5V or more of AC, for either X or Y, something is wrong (probably a bad chip in the analog video section of the PCB), and you do NOT want to hook up a monitor to the board.

Step 2: Test all six frame transistors

The next step is to test the six 'bottlecap' transistors, which are mounted on the monitor frame. Four of these do most of the 'heavy lifting', in terms of generating the current that drives the yoke, as well as two of them that are part of the power supply.

One side note about these transistors: One or more of these transistors will often blow if there are problems with the monitor. Many people trying to diagnose a dead 6100 will often find a bad frame transistor, and think they have found the problem. However, bad frame transistors are more often a SYMPTOM of some other problem (usually on the deflection board), rather being the CAUSE of the monitor failing. Therefore, do not be surprised if you replace the transistor(s), fire the monitor up again, only to find that they blow again right away. As they can be a couple of bucks each, this can add up, if you do not determine the root problems with your deflection board.

To test the transistors, you will use the diode function of your DMM (google 'transistor testing' if you aren't familiar with how to do this). You also want to test them from the connectors (i.e., the ones that plug into the deflection board), as you'll be testing the wiring and sockets too if you do it there, instead of measuring on the transistor pins directly. Some problems with setting up 6100s can stem from issues related to the wiring, and/or the solder joints connecting the wiring, so you always want to include them when checking the transistors.

Also note that just testing to make sure the bottlecap transistors are not shorted to the frame is not enough, but you should do that too, in addition to the diode test. Check to make sure there is no continuity from the metal body of each transistor to the monitor frame, using the continuity function of your DMM. If any of them are shorted, there is a problem, and you'll want to track down the short.

Also, there is a technique I use to test the frame transistors, which makes it pretty simple, and removes the details of having to know about which pin is which (collector vs emitter), and the polarity and type of transistors (PNP vs NPN), etc. When you get familiar with this technique, you can blow through them and verify all 6 frame transistors in under a minute. I'll summarize it here. (a.k.a, 'How to test your frame transistors using this one weird trick'):

(begin transistor test procedure)

Each frame transistor has 3 wires connected to it. These wires go to a connector that plugs onto the deflection board. Each of these connectors has two sets of three wires going into it, from two frame transistors. (So there are three connectors total, for six frame transistors.)

The wires on each connector are logically grouped into two sets of three. One set of three are all next to each other, on one end of the connector. The other set of 3 straddles the key pin, on the other end of the connector. But the important thing to note is that the transistor's 'base' pin is the center wire, for each group of three. The other two are the 'collector' and 'emitter', but you don't need to know or care which is which. (Note you also don't need to know what the base, collector, and emitter pins of a transistor do, in any technical detail. You don't even really need to know the names for the purpose of this procedure, but I'm mentioning them here anyway.)

Take your DMM, and set it to diode test mode. Stick the red lead into the center (base) pin for one of the two sets of 3 wires (it doesn't matter which set). Then take the black lead, and touch it to each of the adjacent two pins. When you do this, you want to look for a 0.5-0.7V drop to BOTH of the adjacent pins.

If you don't get the drop to both adjacent pins, reverse the polarity of the leads (i.e., stick the black lead into the base pin instead, then test to the adjacent two pins.) One of the two polarity cases should give you the voltage drops to BOTH pins, and the other polarity case should give you an open-circuit ('OL' on some meters) to both pins.

If you don't see the two drops for one polarity case, and the two opens for the other polarity case, the transistor is bad. Replace it. (And for another tip, use a silicone thermal pad, (a.k.a., 'silpad') instead of the mica insulator + grease, as they are better, faster, and are no mess, as you don't use thermal grease with them. Digikey part number BER210-ND).

Once you got the two drops and two opens, the last step for this transistor is to test between the outer two pins. In both directions, you should see an open circuit. If you see any voltage drop, or a short, the transistor is bad. (Note it is possible to get a bad transistor that gives you the two drops to the base, but then is shorted across the two outer pins (I've seen it happen), so it's important to test the outer pins as well.)

Now, for whatever polarity you used to get the two voltage drops for that transistor's set of 3 wires, test the other transistor's 3 wires, but use the other polarity (e.g., if you had the red lead in the center pin for the first set of 3 wires, use the black lead in the center now, for the other set of 3 wires.) You should see the 0.5-0.7V drops for both adjacent pins, opens in the other direction, and opens across the two outer pins (in both directions), just like the first transistor.

So, that's it for two transistors (i.e., one connector). Now just repeat the same procedure above for the other two connectors (4 transistors). Once you do it a couple of times and get the pattern down, you can blow through all 6 transistors in about a minute.

(end transistor test procedure)

<u>Step 3: Inspect and install boards, and check ALL wiring</u>

The next step is to physically inspect and install the boards in the monitor, but not connect any wiring yet. This section is explained in two parts, one for the deflection and neck boards, and another for the HV board.

Deflection and neck boards:

You'll want to check ALL wires and connections for breaks, both before and after you have installed the boards in the frame. As mentioned earlier, the wires are very brittle on all boards, and it's VERY VERY easy for them to break during installation. This is due to the fact that the boards use solid core wire, and have very poor strain relief, which means many of the wires can only be bent a few times before they snap. This is especially true where the wires are soldered to the PCBs directly, on the deflection and neck boards. CHECK ALL OF THESE connections, and if any of them are floppy, unsolder them, clip of the end, re-strip, and re-solder them to the board.

Also (and this should go without saying), but if there are any burned components on the deflection board (or any of the boards), something is wrong, and you should not apply power to them. Any charred parts are bad, and you only risk making things worse by applying power. Note the only exception to this is if a board has been burned from a previous failure, then repaired, in which case the PCB may look charred in places, but the components should not be.

If your deflection board is a revision P314, and has the Input Protection Circuit (IPC) daughterboard on the back side of the deflection board (as it sits in the frame), check the legs. The IPC is a roughly 1.5" x 3" board, that is elevated above the deflection board on 'stilts', made of bare wire. These were added by Atari to some P314 boards, to try to protect the deflection board from cases where a malfunctioning game board outputs damaging signals to the monitor. (The later P327 and P329 deflection boards had this circuitry incorporated into the layout, and therefore don't have the IPC daughterboard.)

The legs on the IPC daughterboard like to break, and also (very important), the solder joints often fail. Check and reflow all of the solder joints where they enter the deflection board, even if they look ok. They often loosen up, and can just pull right out of the board if you tug on them, as they aren't fully connected. Pro tip: Grab the IPC, and gently wiggle it back and forth. Listen for any of the wires sounding loose and metallic/tinny, or creaky. If there is any sound at all when wiggling the IPC, it usually means one or more of the solder joints is loose, even if the wires look connected. When all of the solder joints are solid, you won't hear any sound when the IPC is wiggled.

I also scuff up the ends of the wires with a file or sandpaper before re-soldering them, as the new solder sticks better to bare metal. I also bend the wires over after putting them through the holes in the deflection board, before soldering them, so they can't pull straight out, if the solder weakens over time.

When you install the deflection board, I only use one screw, on the right front hole. This is enough to keep it secure, and it's easier to access, as installing the one on the left hole means you have to get your hand (and a screwdriver) near the neck, which only increases the risk of accidentally whacking it and necking the tube, so it's best not to risk it.

HV board:

For the HV board, it is usually the most physically robust of the three boards, but you should make sure the HV adjustment pot is solid, as these often dry out and crack, due to the heat. If it looks excessively yellowed, replace it, as there's a good chance it may be heat damaged, and often the plastic dial will fall apart when you try to turn it. (It's really best to just replace it regardless, if it looks like the original one.) It's a 25K pot, Digikey part number 201UR253B-ND.

Also, inspect the HV transformer (aka flyback, the big black thing with the wire coming out of it that goes to the tube). These usually don't go bad, but it does happen (I think I've seen two bad ones). When they do fail, they typically short internally, and melt. If you see any signs of heat damage on the outside of the transformer (particularly on the side facing the open side of the cage, which is easiest to see), it's probably bad, and should be replaced.

Also, you want to check the focus and screen wires. These are the two short thick wires (one red and one white), which run from the focus + screen adjustment block (with the two knobs on it, on the outside of the cage) to the 2-pin Molex connector mounted on the cage. These wires have boots on them, where they connect to the focus block. Slide these boots back, and you should see connectors for each wire, where they fit on to the pins on the block. Pull them off. They should fit on each pin snugly, and give some resistance when you pull them off. If they pull off too loosely, squeeze the metal connector to tighten up how it fits over the pin. Slide it back onto the pin, so it fits snugly, then slide the rubber boot back over the connector. Do this for both the red and white wire.

Also, make sure the black ground wire that is soldered to the focus block is soldered securely, and is plugged on to the single post connector on the HV PCB.

Finally, if you're working with unknown-condition boards, make sure none of the components on the HV board are burned. It's not uncommon for some of them to look browned (e.g., some of the resistors). Those are usually ok (but can be replaced if desired). However if anything is charred, there is a problem, and you should not power up the cage.

Make sure the three wires that go from Q906 up to the bottlecap transistor on the back side of the cage (closes to the tube) are intact and ok, with solid connections.

Finally, make sure the wires and slide-on connector for Q900 (on the outside front of the cage, to the left of the focus block) are ok. Make sure the slide-on connector is not yellowed or heat damaged (if it is, you can cut it off and solder the wires directly to the transistor. Just make sure to insulate them with heat shrink tubing, to make sure they don't short to the metal cage). And lastly (and this is important), if the connector is ok, make sure it is installed properly, and not backwards (as it is possible to put it on two ways, ask me how I know...) The tab in the connector should fit into the slot in the metal cage.

When you bolt the HV cage to the frame, it isn't necessary to install the two screws that are behind the cage (i.e., between the cage and the tube). These are a pain to get to (and just increase your chances of accidentally necking the tube), so don't worry about them. The cage is plenty secure with just the two screws on the front, and the one on the side.

Also, if you have a mesh cover for the HV cage, it's easier to install it before you bolt the cage to the frame, as it is harder (and riskier) to install the two screws for it after it's already in the frame. However, that said, I prefer to not have it on as I bring the monitor up (as I want to be able to see if anything goes wrong inside the HV cage), so it's best (but more work) to leave it off while bringing the monitor up, and then remove and reinstall the cage later, to put the cover on, after you're sure the entire monitor is working properly.

That about covers it for inspecting and installing the boards. Now we can start testing them, and bringing the monitor to life.

Step 4: Test the low voltage (LV) section of the deflection board

Next, we will test just the deflection board. With it installed in the frame, plug in ONLY the 2-pin degaussing coil, on the back left side of the board. Leave all other connectors unplugged from the deflection board (and make sure they are safely out of the way of the headers). You will also want the game board unplugged from the cab harness during this step.

Note this document assumes you have a low voltage replacement board installed on your deflection board (either an LV2000, or LV6100, which are basically different versions of the same thing, made by two different people). If you don't have one, get one, as they are a no-brainer upgrade for all deflection boards.

Instructions for checking the LV section are in the LV2000 manual, under 'Testing your work':

http://vector-repair.com/lv2000is.pdf

Note that if you have an LV6100 instead of an LV2000, you should measure around +24V and -24V, not +/-28V. This is normal, and ok.

Step 5: Test the deflection system and neck board

If the LV section checks out ok, the next step will be to power up and check the entire deflection system, which is made up of the deflection board, frame transistors, and yoke. (And we'll power up the neck board while we're at it, though it's technically not part of the deflection system.)

So, the first step is to plug in the rest of the connections for the deflection and neck boards. The connections are listed here for each board. Note that some of the connectors can technically fit on to more than one place, so you want to make sure you have every plug's location correct:

Deflection board connections:

- Degaussing coil (2-prong connector on back left side of board. Should already be connected, from deflection board LV testing steps above).

- All 3 frame transistor connectors. (Be sure not to swap the two on the left side of the board. The P100 and P700 connectors correspond to the two holes in the frame where the wires go, for each connector.) There is also the P600 connector on the right side, which connects to the 2 frame transistors on the right side of the frame.

- The yoke connector P701
- The neck connector P101
- The 3 single wires, marked BLK, BRN, and WHT/BLU, on the right front corner of the board.

Neck board connections:

- The 8-pin-wide connector on the bottom of the board, that comes from the deflection board.

I also like to zip tie some of the wires together for the neck and deflection boards, where they run near each other, to give some strain relief and allow them to support each other when they are pulled on. Every bit helps.

Also, make sure no wires are touching any of the large (usually white) ceramic power resistors on the deflection and neck boards, as these resistors get very hot, and can melt the wires if they are making contact.

Next, we will power the deflection system up. I like to do so WITHOUT the game board connected first. This protects the game board if there is a problem (though it's nearly impossible for a monitor to damage a game board), but more importantly, it gives us a little more information should something go wrong, as the system will be less active if the deflection system is only powered, but isn't being driven by the game board, which narrows down the set of components that could have issues.

So, with the game board unplugged, connect the deflection board to the cab harness, and power up the cab (with the brick and AR connected to the harness). You should see the two lights on the LV2000 light up, as well as the red spot killer LED lit, on the deflection board. Make sure you hear no buzzing, shorting, or otherwise Bad Electrical Sounds, and make no fuses blow. (Feel free to power down, and check the 5 fuses on the deflection board with your DMM for continuity to be sure, if there is any doubt).

If the fuses and everything else look good, connect the game board to the cab harness. Make sure the Test Mode switch (inside the coin door) is OFF (i.e., in the center position), and power up the deflection board again. You should immediately see the spot killer LED flash quickly and then go out, and you should hear deflection 'chatter' coming from the system (mostly from the yoke), which is a whirring/buzzing sound, that will change as the game cycles through attract mode. If the spot killer LED stays lit, and/or you don't hear chatter, something is wrong. Power down, check fuses again, and test all six frame transitors again (using the procedure from Step 2, above).

If you have chatter, you're most of the way home. You still won't have a picture yet(as the High Voltage system isn't running), but a good part of the system is working, and the next step will be to connect and bring up the HV.

If all looks good, power down the monitor, and unplug the game board from the cab harness, as it won't be needed again for a bit.

<u>Step 6: Connect high voltage (HV) cage wiring, and set up the HV probe</u>

Next, we'll connect and bring up the HV cage. We will use an HV probe to monitor the HV as we apply power, so we can see what's happening, and shut down quickly if things don't look right.

The first step is to make the electrical connections to the HV cage, which involves plugging in the following:

HV board connections:

- The red and white 2-wire plug, which goes to the neck board. Be careful pressing this into the connector on the HV cage, as for some cages the connector is mounted in a thick cardboard holder, which can break easily if pushed too hard. On later cages, the holder was changed to metal, but either way, it's best to support the back of the connector when pushing the plug in.

- 8-pin-wide connector at P500.

- Also inside the HV cage, make sure the single black ground wire from the Screen and Focus control block is connected to the single post labeled 'BLK'.

- Plug the anode wire into the tube. Make sure the clips are securely in the hole, and the suction cup is secured over the clips. Also, it's a good practice NOT to touch the hole in the tube without discharging it first, even if the tube has been sitting for a while, as the tube can build up enough of a charge from just sitting to still give you a good zap (which can startle you and cause you to neck the tube). I just make it a practice to never touch the hole directly, and I always handle and insert the anode by the suction cup, so the rubber is always between my fingers and the hole. This way I never get shocked, even if there is residual charge on the tube.

(begin brief aside about discharging vector monitors)

It's also worth mentioning here that 6100's are self-discharging monitors. The HV bleeds off pretty quickly (in well under a minute), once power is removed from the monitor. I would never tell you not to discharge a monitor before touching the tube, but I never discharge mine anymore when working on them, but I also never touch the anode hole directly, and always hold and insert the anode using the rubber cup. However the reason for telling you this, is that if you do try to discharge the tube with a HV probe or screwdriver, be aware that you will normally not hear a snap or pop (unlike many other raster monitors), as the monitor does bleed off most of the charge itself.)

It is also worth mentioning that, contrary to some historical beliefs, it is ok to discharge a vector tube with a screwdriver tool (i.e., bleeder resistors or an HV probe are not required, though they are fine to use). It is somewhat moot for 6100's because they are self-discharging, but even for black-and-white vector monitors, there are no documented cases of this damaging a monitor, and many known cases of people using a screwdriver (sometimes for years) without a problem. I believe this idea originated from a hypothetical discussion that took place on RGVAC, and within the hobby, 20+ years ago, and morphed into 'tribal lore' if you will, becoming a recommendation, without any empirical data to back up that it was in fact necessary. That's my understanding based on the research I've done into the topic, anyway.

(end brief aside about discharging vector monitors)

Next, we will set up the HV probe. Note this section assumes you have one, and you really should, if you are going to set your monitor up properly. Some people say you can estimate the HV by measuring the B+ voltage, however I know firsthand that this is not practical, as the adjustment pot is very sensitive, and using the B+ alone to estimate the HV is not precise enough to get to the required 19.5kV HV setting with any degree of accuracy. You will be off by hundreds if not thousands of volts. (Also, adjusting the B+ doesn't actually guarantee there is proper HV at the tube, for example if there are any problems with the HV transformer.) So, buy or borrow an HV probe. You can get a used Fluke 80k-40 for $50-80 on ebay. Or, any other probe rated for 30kV or more will do.

(Note that if you do not have an HV probe, AND you got your HV cage from me, you can likely leave the HV pot set as-is, as I measured and calibrated it when I tested the HV cage. It will likely be 'close enough' to be ok, though technically it should be adjusted for the deflection and power supply boards and brick used in your cab, which could be slightly different than mine.)

Pro tip (IMPORTANT): When using an HV probe, never stick it under the anode cap while the monitor is already powered on. You always want to position and insert the probe with the monitor OFF, then turn it on and watch the voltage, with your attention (and hand) ready to immediately kill the power if there are any problems.

The main reason for not inserting the probe with the monitor already powered on is that it's fairly easy (especially with 6100s) for the anode wire to pop off when the probe is stuck under the cap. Needless to say, you do NOT want this to happen while it's live, and have 20,000 volts flopping around loose inside the back of your monitor. This will be Very Bad.

I like to position the probe on top of the HV cage (I have a Fluke 80k-40, which fits almost perfectly), and wedge it under the anode cap, with the tip of the probe between the two prongs of the anode clip (while the clip is plugged into the tube), so the probe can't slip out sideways. Also, placing the tip between the two prongs puts light outward and upward pressure on them, which helps lock the anode wire in the hole. Be sure to clip the probe's ground lead to the frame. (I use the holes on the ears of the front of the frame, as the clip grips well here, and is less likely to pop off.)

I prop the probe so it stays put without having to hold it, and I put the meter where I can see it clearly, as I stand a few feet away when powering the monitor up. You want to see the meter, and be able to kill the power instantly if anything goes wrong. Not holding the probe in your hand makes it impossible to 'slip', and it lets you focus your full attention on the rest of the monitor when applying power (in addition to not being startled and accidentally necking your tube if something pops when power is applied).

Most HV probes put out 1 volt to the meter for every 1000 volts measured at the tip, so you will need your meter set to a 20V range (or more) if it is not auto-ranging, as the target level to set the HV to will be 19.5kV. (Note it is not the same for different models of monitors, so always check the manual for non-6100s.) Plug the probe into the meter, and make sure you can see the meter clearly from wherever you will be standing when you turn the power on.

Before you apply power, you can check to verify that the HV adjustment pot is approximately in the right position, as if the rest of the monitor is ok, the pot should always be in the same general area, which I call '2 o'clock'. This means if you are standing in front of the FRONT of the tube, looking down into the HV cage, with the large black HV transformer furthest from you, and the opening of the cage to the left, and the two metal legs of the pot closest to you, then the slot on the pot's adjustment wheel should be pointing at about 2:00 (i.e., towards the upper right, to the right of the HV transformer.) The range of the pot is about 7:00 to 5:00, and 2:00 will get you in the right general area. If you find that the pot needs to be cranked up all the way high or low to get the required 19.5kV, there is a problem somewhere (likely in the HV cage), and you should not operate the monitor this way, even if you can get the right HV level.

Note that the above paragraph holds if you have a revision P316 HV board. The later P329 was modified with an additional HV limiting circuit, which allows you to set a cutoff threshold using a second pot, and the circuit will disable the HV circuitry if the HV exceeds this cutoff level. The circuit was added for safety reasons, as excessive HV can emit x-rays, and other electromagnetic interference, so it's better to shut the HV down if there are problems that cause it to rise to unsafe levels.

If you have a P316 HV board, you must perform the calibration procedure for the cutoff level, using the second pot on the HV cage. This procedure is found on the page labeled page 9 in the Atari TM-183 6100 Manual, 3rd Printing (see URL earlier in this document.) You will need to read it before powering the monitor on, and perform the procedure after powering it on. (The remainder of the procedure below assumes you have a P316, without the HV cutoff circuitry).

Before applying power, it's a good idea to set the screen and focus knobs on the adjustment block (outside of the HV cage) to roughly their center positions. We will fully adjust them after we power up the monitor, but it's a good idea to not have them maxed out to either extreme to start with.

Also, we will perform the initial power up of the entire monitor (including HV) with the game board unplugged. We will need to measure and adjust the HV first, which requires 'zero beam current' conditions, which means no signal from the game board. So just make sure the game board is unplugged from the cab harness for now, and we'll plug it in again later, once we verify and adjust the HV.

Step 7: Powering up, and checking the HV and B+

With the HV probe set up, meter on, all monitor boards connected, and game board UNPLUGGED, power the entire monitor on, while watching the HV level on the meter.

You should see the HV shoot to somewhere between 15 and 20kV pretty quickly. If it doesn't, shut it down immediately. Also, if possible, watch the LEDs on the LV2000/LV6100. They should both be lit. And, the spot killer LED on the right front corner of the deflection board should be lit, because there is no signal coming from the game board (which causes the spot killer circuit to kill the beam, so you don't burn a hole in your screen.)

(begin brief aside about the spot killer)

Note that the spot killer is a very useful troubleshooting tool. However, it has some caveats, which must be taken into account when trying to use it for debugging purposes, otherwise it can be misleading if you do not fully understand how it works.

The spot killer LED goes OFF when there is deflection happening on the X and Y circuits of the deflection board and yoke. This NORMALLY indicates signal is coming from the game board. HOWEVER, not always, if there is a problem.

It is possible for XY signals from the game board to be present at the deflection board, but if there are problems with the actual deflection circuits (e.g., deflection board amplifiers and/or frame transistors, etc), there will be no deflection occurring (i.e., no current flowing through the yoke wires), and hence the spot killer will be lit.

So, if the monitor is working properly (i.e., picture exists on the screen):

spot killer lit = no signals from game board
spot killer off = signals and deflection are present

However the above does not hold if there is no picture on the screen, or if there is some other issue causing the monitor not to work. In this case, a lit spot killer USUALLY just means no deflection, which can mean no signals from board, but also potentially a problem with the deflection board (e.g., blown frame transistor or other issue).

Similarly, spot killer off USUALLY means deflection is happening (which implies XY signals from game board are present), BUT it can also potentially mean the spot killer LED is dead (which does happen), and/or there could be an issue with the components driving the LED.

In these cases, one trick to confirm that the spot killer is actually working is to press the reset button on the game board, while watching the spot killer LED. The LED should light briefly while the reset button is depressed, and go off again when released, as soon as the game board starts ending signals again (which should happen within a couple of seconds). If you can confirm this behavior, you can trust that the spot killer is basically working.

Also, be aware that the spot killer behavior can be unpredictable if only SOME of the game board and/or deflection signals are present. I have not studied this in full detail (e.g., simulate all combinations of just X or just Y game board and/or deflection signals), but just a heads up, if you are seeing inconsistent behavior, you may want to manually confirm that the game board is transmitting valid X and Y signals via the test points, using a DMM (see instructions in Step 1 above.)

(end brief aside about the spot killer)

If any of these things don't look right (or if you see any smoke, or hear any popping, buzzing, sizzling, or other Bad Electrical Noises), kill the power immediately. You might want to keep your finger on the power switch for about a minute. Most Bad Things usually happen immediately, but if it runs for a minute or so without anything bad happening, you're most likely ok, at least for the time being.

If all looks ok, then it's time to adjust the HV. Using a small plastic screwdriver or monitor adjustment tool, turn the HV adjustment pot to adjust the HV level on the DMM. Note that in order to get this adjusted perfectly, the monitor really needs to be fully warmed up. If the monitor is cold, I usually set it to 19.0kV, and it will rise to about 19.5kV as it warms up. Better to be a little low than a little high, so you don't want to set it to 19.5kV cold, as it will definitely be too high once it warms up. It's not necessary to wait for the monitor to warm up fully right now, if you don't want to. (But you should monitor the HV later, and adjust to 19.5kV with the entire monitor fully warm, after about an hour or so).

As one last step before powering down again, we want to verify the B+. If everything else so far has been ok, and you were able to adjust the HV without any issues, this step should just be a verification step. You should only need to measure it here, and confirm that it is where it needs to be.

The easiest place to measure the B+ is on the neck board, on the upper left corner of the solder side (with the monitor oriented horizontally). Put one DMM lead on the monitor frame, and carefully probe the solder joint of the leftmost pin (looking from the back of the neck board) of the J501 connector (which is labeled 'VID B+' on the parts side). You should see somewhere around 180-185V, though it could be a few volts higher or lower than that. If it is significantly higher or lower, power down the monitor, as there is a problem.

If the B+ looks ok, power down, and finally we'll connect the game board, and get some vectors on this puppy. (Finally!)

<u>Step 8: Unleash the vectors!</u>

Else, if there are no blown fuses, and the LV, HV and B+ are measuring properly, the next step is to power up the monitor fully, with the game board connected.

Before doing so, check your game board, and set all of the video adjustment pots to their center positions. This includes the SIZE, CTR, LIN, and BIP pots, for both X and Y. This should result in a decent starting point to adjust the picture from, as if they are way out of adjustment, it can trip the spot killer (if they are set too low), and/or potentially damage the monitor (if things are turned up too high.)

So you've earned it at this point. The moment of truth. With the game board connected, power the monitor on (while still watching the HV probe, which is a good idea to leave connected, as it's just another indicator that can tell you if things are ok, and the more info we have, the better).

It may take some time (maybe up to 15 seconds or so, depending on the health of the tube), but you should see a picture. If there is no picture, try adjusting the screen control, as the brightness might just be turned down too low. If there is a picture, but it is not complete, or half of it is missing, or there is just a flat line, or if there is just a colored blob on the screen, kill the power immediately, as something isn't right.

If there is a picture, and it looks roughly ok, adjust the focus and screen (i.e., brightness) controls to taste. Then adjust the size and centering pots on the game board to get the geometry right. (See the game board's user manual for more on adjusting these, particularly the linearity pots.)

From there, it's mostly just a matter of tweaking, particularly the color bias and drive pots on the neck, to balance out the colors. This is explained in the 6100 manual, but as long as all 3 colors are present to some degree, you should be ok. (If any are missing entirely, this suggests an issue on the neck board, or possibly it's just not seated well on the neck, so power down, remove the neck board, and re-seat it).

(Editor's Note: There is probably some opportunity here to add tips for adjusting the color pots on the neck board, but I need to figure out the details for this, as I usually just fiddle with them every time I set one up, and I need to sit down and write some stuff down. However in the meantime, the instructions in the 6100 manual explain the procedure pretty well.)

Now go enjoy your game! (And good job!)

Summary

So that's about it (or at least as much as I can brain dump for now). I know this is a lengthy doc, but I just wanted to share as many tips as possible, as I know from experience how fussy 6100's can be sometimes.

I sometimes describe bringing a 6100 up as being like stacking beach stones. You just need to go slow, be careful, and with patience, you'll end up with something beautiful.

But once you get one running and tuned, they're usually pretty reliable, as long as the game board stays stable. (So the best advice at that point is DON'T MESS WITH IT.) ;)

If you have any questions, issues, suggestions, etc, please don't hesitate to PM or email me anytime.

-Andy

Document Revision History (newest first)

v20170517 - Initial release.