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November 2005

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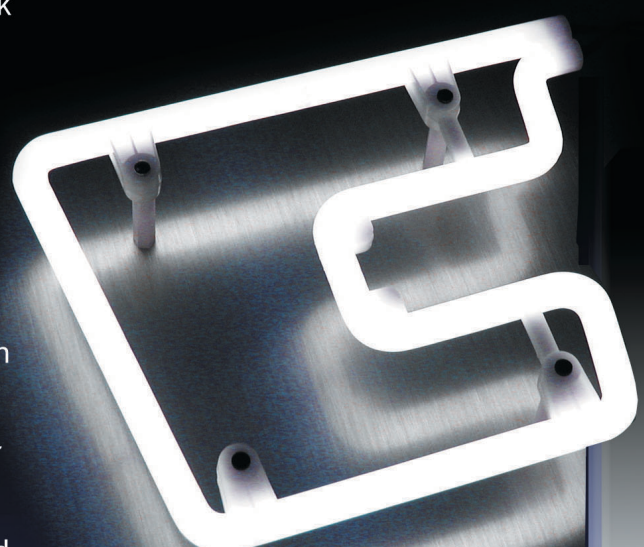

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Slot Tech Editorial

Welcome to the "almost completely all about monitors issue" of Slot Tech Magazine. It wasn't intended to be this way. It just sort of happened. It happened, among other reasons, because my friend Chuck Rabiola from Wells-Gardner Electronics volunteered to give his first ever presentation at TechFest 12. He asked me what I wanted him to discuss and I said "U3000!" There are quite a few of these monitors out in the field and they have a number of unique problems associated with them as they have aged over the years. I asked if he could possibly prepare a "cheat sheet" of monitor symptoms and solutions. As a technician, I'm not concerned with proving to everyone how smart I am by finding every problem on my own. If I have a sheet of paper with all of the most common problems associated with a monitor, I'm happy to use it. Chuck provided us with some very useful information about their U3000 and U3100 models and I have reprinted it in this month's issue. Thanks, Chuck. Nice job.

Also in this month's issue is the conclusion of our eight part series on the Tovis digital monitor. This was a fun project as it gave me the opportunity to analyze each and every circuit in the monitor and really take the time to describe how each circuit functions. The series concludes with the EHT circuits, including the dynamic focus. This is a very interesting circuit that combines high voltages with complex waveforms in order to maintain perfect focus on a flat CRT. I'd like my next project to be a review of Tovis' amazing 32" LCD monitor, if I can just convince them that it will take at least a year to review it properly!

Herschel Peeler also checked in with his look at the active power factor correction in the Kortek monitor. Like I said, we didn't plan this. I never know what Herschel's going to contribute but it's always something interesting. So in this issue, we have something really in-depth about Kortek, Tovis and Wells-Gardner. Sweet.

In closing, I'd like to thank all of the companies and individuals that participated in TechFest 12. We had a great time and learned a lot (did you know that the Ithaca 850 performs a TOF sensor calibration every time you swap software? I didn't). I neglected to snap a picture of 3M TouchSystems' Mark Roberts during his presentation (he showed us a new adhesive for bonding the touchscreen sensor to the CRT or LCD, an adhesive that removes easily with no tools and leaves no residue) so I have put together an incredible recreation here.

See you at the casino

Randy Fromm

TechFest 13 will be held at Mystic Lake Casino in Minneapolis, MN May 16-18 2006

Randy Fromm's Slot Tech Magazine

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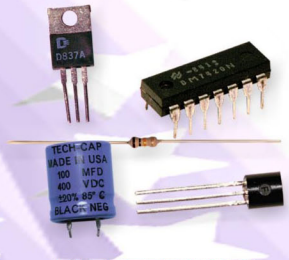

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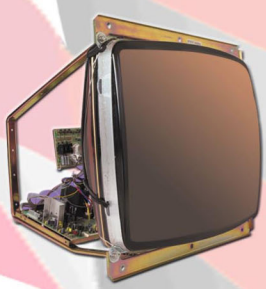

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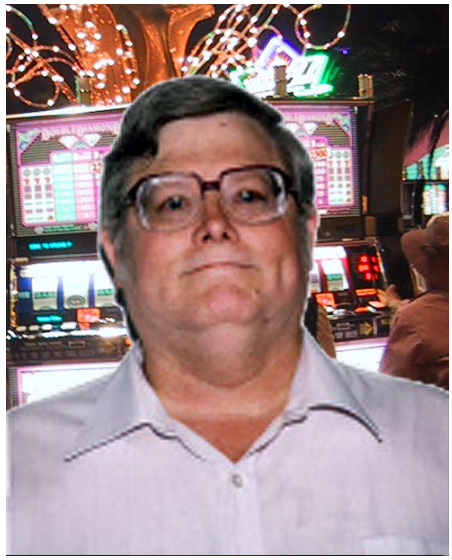


Power Factor Correction and the MC33260

By Herschel Peeler

It's all the rage these days. It's the topic on the Slot Tech Forum. It's the green movement in the industry. Power Factor Correction, Power Line Harmonics. That's what we are talking about here today folks. Here's one way to add PFC (Power Factor Correction) to your monitor or power supply without a complete redesign of the board. Unplug your Bridge Rectifier and plug in a small board in its place. The MC33260 is a Power Factor Preconverter that handles PFC in your circuit. I have a feeling we will be seeing more of these guys in the future. So let's get to know how they work so we can troubleshoot them.

Some manufacturers add them to their monitors. We see it as a board wired in to where the bridge rectifier used to go in Kortek monitors. The bridge rectifier is moved to the board and the PFC circuit is added. For only a few bucks the PFC circuit is added to the monitor. This same thing can be done to virtually any power supply, but is more popular to SMPSs since they have a bigger problem with line harmonics and power factor.

The Problem

In any power supply, the current is not in phase with the voltage. Current does not necessarily peak when the voltage peaks. After the AC is rectified, it charges up a filter capacitor (bulk storage capacitor) and the load is actually running off of the charged up capacitor. Taking a close look at what is happening here, we realize that current only flows between the rectifier and the capacitor when the applied voltage is higher than the charge on the capacitor. Current through the load is a constant DC (coming off of the capacitor) but the current through the AC line up to the filter capacitor is actually heavy spikes as the capacitor gets recharged. Each time the capacitor takes a charge, the line voltage takes a hit and line voltage slumps, deforming it from a pure sine wave. Our AC sine wave actually deforms so that our 60 Hz signal gets modulated by the first and third harmonics. Our power line exhibits what is known as Harmonic Distortion. And, although the sum of the primary current (source and return) is zero, harmonic currents are additive, translating into waste current and waste heat.

As a side note here we should also notice why our game, or monitor, draws a high current when we first turn it on. These filter caps are high value capacitors. They have, in essence, a very low resistance when they are discharged. It takes a few cycles of incoming power to build up a charge on all the filter caps in the power supplies in the game. During this time, our line voltage takes a heavy draw for a few tenths of a second. A monitor that normally draws only an amp or so may draw three amps when powering up. The power supply in the game does the same thing. If you have a thousand games on the casino floor, that is thousands of power supplies drawing many times their normal current when your whole casino comes up at the same time, as when line power takes a hit. The MC33260 has a "Soft On" feature built into it also to help deal with this problem. You see why I think we will be seeing more of these used in games in the future?

The MC33260 pinout

Let's take a pin-by-pin tour of the MC33260 and see what this guy does and what features it has.

Pin 8 is Vcc. This is typically around 12 to 15 Volts. Tight regulation is not required. The MC33260 does not power up until Vcc gets above 11 Volts. Once up and running, it will operate until Vcc drops below 8.5 Volts. Pin 6 is Ground. Note that this ground is the SMPS (Switch Mode Power Supply) primary ground.

Pin 1 is the Feedback Input. It is usually connected to the preconverter output voltage through a high resistance. The data sheet shows two 1 Megohm resistors and this is what we find on the add-in board (In fact the suggested design in the data sheet is almost identical to that of the add-in board in the Kortek monitor). The voltage applied to pin 1 is used to regulate the output voltage and is also used to sense under-voltage and over-voltage error conditions. The current drawn at pin 1 is also used to power the oscillator circuit of the MC33260. The voltage at pin 1 should be between 1.5 and 3 Volts, typically between 2 and 2.5 V.

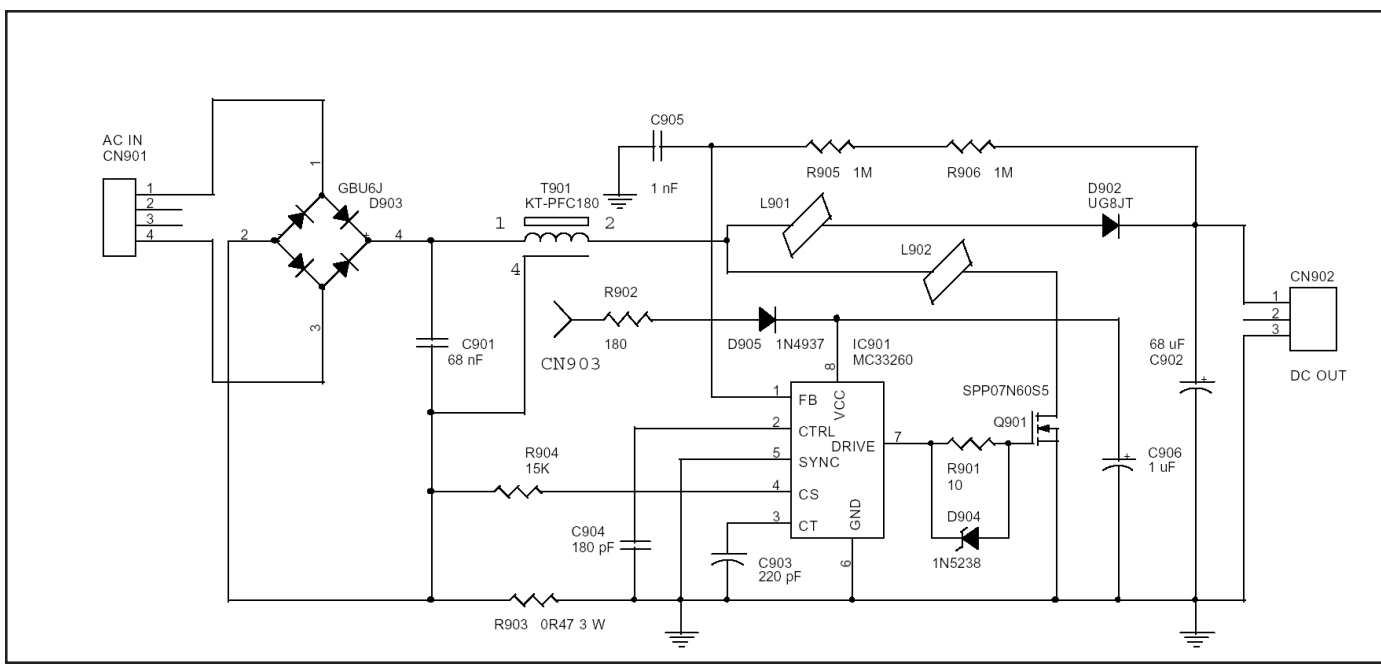
Pin 2 is the control voltage. Usually, this pin has a capacitor to ground. This determines how fast the MC33260 is going to respond to changes. This sets a "bandwidth" for operational sensitivity. Typically a 680 nF capacitor gives us a bandwidth of around 20 Hz. Low stress here. Seldom would I expect to find failures in this circuit.

Pin 3 is the oscillator capacitor. This capacitor determines the operating frequency of the MC33260. The typical design of the MC33260 is that of a Boost-type SMPS. This capacitor determines the operating frequency, typically 400 KHz, or so. This should be a saw tooth waveform at about 1.5 V.

Pin 4 is the Current Sense Input. A resistor between the ground side of the bridge rectifier and the SMPS primary ground is used to sense current. Keep in mind that the ground at the rectifier is not ground in the SMPS. The voltage across this resistor may be as much as a volt. There is typically a current sense resistor of less than 1 ohm between pin 4 and ground going to the SMPS. Take a close look at the schematic diagram. This current sense resistor is a potential point of failure.

Pin 4 is used to monitor the current for zero current detection and peak current limitation. Normally, this should be a small negative voltage (higher than -60 mV), referenced to SMPS primary ground. If less than –60 mV is sensed, the MC33260 will not start up.

Pin 5 is the synchronization input. In most simple applications, this pin is grounded. It can be used to turn off the MC33260 if the SMPS it is



connected to is powered down due to a failure of some kind. An input higher than about 1 volt shuts down the MC33260.

Pin 7 is the gate drive output. We should have a square wave output here at the operating frequency, between ground and Vcc. The MC33260 is intended to drive an N-Channel Enhancement Mode MOSFET but is capable of driving up to 500 mA to Vcc and Ground and can be used as the engineer imagines. An IGBT (Insulated Gate Bipolar Transistor) is also suggested as an option to using a MOSFET. The MOSFET is another likely point of failure here. The MOSFET being shorted can put a voltage here higher than Vcc, taking out Pin 7 in the process. If the MOSFET is shorted, check the resistance to Vcc and ground at Pin 7. It should be a high resistance.

Editors Note: We had exactly this failure in a Kortek KT-1703NA during my monitor repair demonstration at TechFest 12. When we left to take a break, I left the monitor chassis exposed and energized in order to give the slot techs a chance to practice measuring the B+ voltage. When I returned, the fuse was blown (someone had picked up the chassis without realizing it was energized and when he/she dropped it back on the table, the PFC board must have shorted to something). There are only three things that will typically blow the fuse: the bridge rectifier, the switching MOSFET (an IC module in this case) and the MOSFET in the power factor correction circuit. I pulled the shorted PFC MOSFET, replaced the fuse and the monitor was back in business in just a couple of minutes, no replacement part required! This is one of the few places in the monitor that you can remove a component and yet it will continue to work perfectly. It just draws a wee bit more current.

The Kortek KT2182

Now that we have basics covered, let's go to a real application. The Kortek KT2182 uses just such an application. The accompanying schematic is what you get from de-engineering a small board added to Kortek monitors. No part number is identifiable on the board. It is about three inches square. Three connectors go to the board. Two connectors are AC IN (CN901) and DC OUT (CN902) that are Black and White pairs going to where the Bridge Rectifier was on the main board. A third, single wire connector, CN903, brings DC Power from the main board to the small board. AC power comes onto the board on CN901, is rectified into pulsating DC by D903. C901 only filters out noise. T901, IC901, C902 and Q901 make up a basic boost SMPS circuit. When IC901's drive output goes high, Q901 turns on. This grounds one side of T901 and a magnetic field builds up in T901. When IC901's drive output returns low, the charge in T901 gives a positive voltage out that builds up a charge on C902. Our Pulsating DC is chopped up into 300 KHz bites. The MC33260 does its power factor correction thing and smoother DC is applied to the SMPS on the main monitor board. Normal voltages you can check around IC901 should be;

Pin 1 - About 2 volts
Pin 2 - Pin 3 - A sawtooth waveform about 1.5 volts high.
Pin 4 - close to ground potential.
Pin 5 - ground.
Pin 6 - ground
Pin 7 - A squarewave between 0 and about 15 Volts at 300 KHz.
Pin 8 - About +15 volts, clean and flat.

Bridge rectifier, pin 1 to ground should be a pulsating DC about 160 V (Peak) high. Pin 2 of T901 should be a square wave about 160 V peak at 300 kHz. C902, + side, should be a +V about 130 V.

The MC33260 is one member of a line of devices with similar part numbers. They are MC3326x part numbers. I'm sure there must be other devices out there. I just haven't run into them yet. Now that you have an idea how the MC33260 works, they won't be a mystery when you run into them in the future.

- Herschel Peeler
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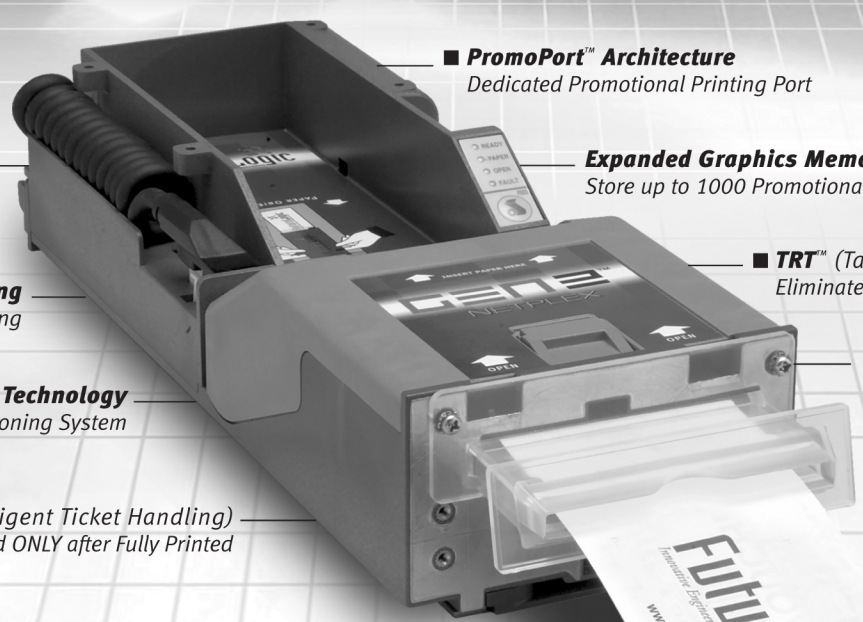

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Quick and Simple Repairs # 8

The Headaches of a Certain Bluebird

By Pat Porath

This certain WMS Bluebird sure had some problems and I sure did learn a lot from it. One of the first problems that we had with it was the Kristel brand of LCD that was in it. Later I found out that WMS games with the Kristel type LCDs in them run into problems. We replaced the LCD and the screen came back, no big thing. Later on we ran into more problems. There were printer communication errors, RAM errors, the touch screen wouldn't respond and the screen would go black when the main door was closed. It was one thing after another. Come to find out that the main processor was coming a little loose when the main door was being closed. It was probably because the main door was kind of hard to close. Makes sense right? After tinkering with the door latch assembly on each side, now it was easy to close. I'm not really sure if the back plane board and the main board were changed out because of the door problem or not but they were changed and FINALLY the game was up and running and "online" as we like to say (online with the player tracking system).

The next day, I went into work and it was down again. What in the world was happening? The LCD had been changed, the main and back plane boards had been changed, the ticket printer had been changed not too long ago . . . now what? Come to find out it has ticket printer problems again. With a little experience under my belt with the combo of the Bluebird and the Ithaca 850, I know that the small square chip (called a PLCC for plastic leaded chip carrier) that is inside of the printer has to be REV 31 or higher. We have on our floor Rev. 28, 31, and 33. I found out the hard way that a Rev.28 chip inside of the printer does not work in a Bluebird. It may work just fine in the newer Aristocrat games, but not the Bluebird. Also as a reminder, the Ithaca 850 DOES NOT LIKE TO BE HOT SWAPPED. You will blow the printer communication board (the small board behind the printer) almost every time.

All right . . . I have a good printer and a good printer COM board. Maybe I can get this thing running. NOT! With the parts installed, what in the world is next? I powered up the game and it went into a "printer lost communication during print." error. Great. Just great. I might as well try a RAM clear. On the Bluebirds, a RAM clear is a little tricky

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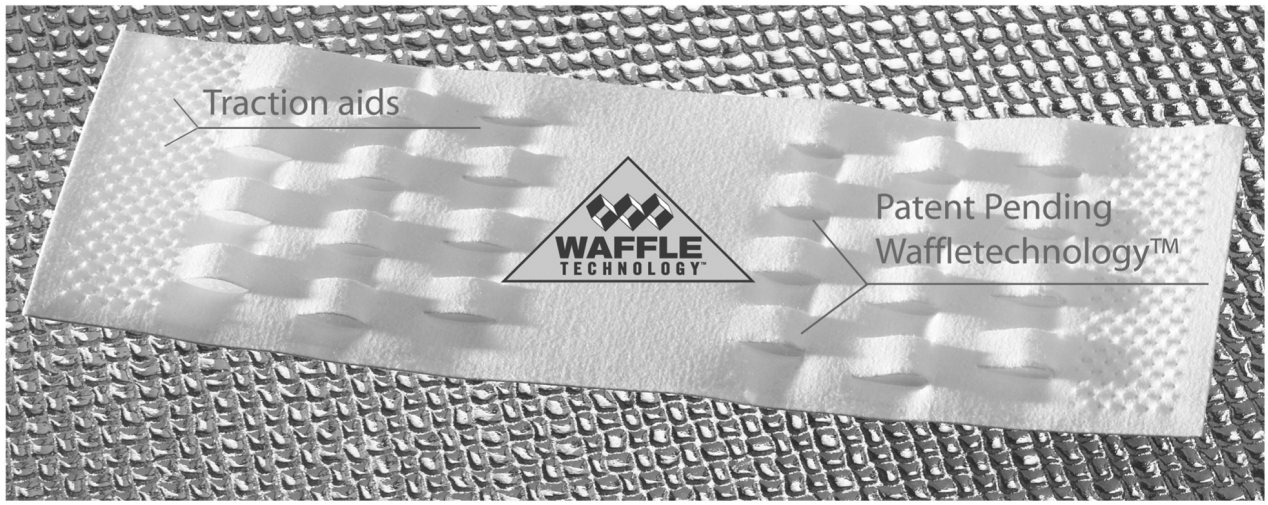

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sometimes. It took me a little time to figure it out. I installed the RAM clear Flash card into the socket closest to the frame, left the other Flash card in its socket and started the procedure. I powered up the game, selected "clear NV ram and EPROM" and selected to "choose this item." I shut the game down and put the game flash card back in place. Maybe now it will be "online." No. While the game was booting up, another error came on the screen. This time it came up with "NV Ram 1 battery low." Nice. Now I have to replace the battery on the main processor board. Come to find out the Bluebird has TWO board batteries. Luckily, they are the simple non-solder button batteries. They are very similar to a watch battery, just bigger. I went up to the shop and looked around but all I could find is the solder type button batteries. No big deal, I just cut off the solder tabs. I put the batteries into the game and powered it up. So far so good. Since the RAM had been cleared, all of the game options needed to be set. Some of the options are: disable hopper, enable ticket printer, no coin acceptor, etc. I started the option process and the screen locked up. I couldn't get out of the "game volume" menu. I tried the reset key switch, the diagnostics button and opening and shutting the hopper door. Nothing worked. Well, back to the drawing board tomorrow.

Well, back at the Bluebird. Come to find out the majority of the problems with the printer communication was the version of the PLCC chip. I'm not positive, but it looks like the Ithaca has to have a Rev.37 chip in it to work properly. I thought that a Rev. 33 would work, but I guess not. Another slot tech checked it and it had the wrong one in it. He installed the proper one, set the options, and the game was back up and running.

Pictured here, is the PLCC chip Rev.37. This chip goes into the motherboard of the Ithaca 850 printer. Other versions we have on our floor are Rev. 28, 31, and 33. These chips can be a bit tricky to take out of its socket without damaging it. The legs can get bent very easily. You should use a PLCC extraction tool to remove them. You also have to make sure that the chip goes back in the way it came out because it will fit either way. If you look close at it, you will see that one corner isn't square. It is cut at a 45-degree angle. There is usually a mark on the board where pin one is. Simply match the angle to the mark on the board. It may be marked by a dot or it might show "pin one" on it. To put the chip back in, it simply snaps into place.

IGT PE-Video Poker

On the older IGT video poker games once in a while one of the card "hold" buttons won't work. You check the connections, the micro switch, the ground wires and all looks fine. The micro switch even tests good with a meter. Now what? Well the problem may

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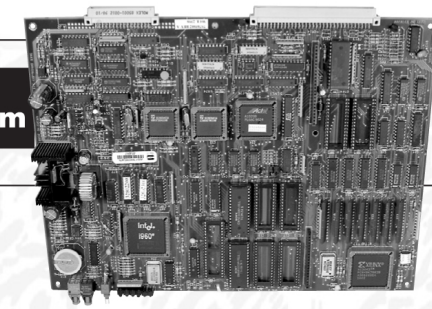

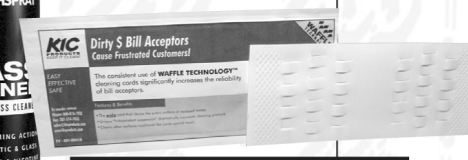

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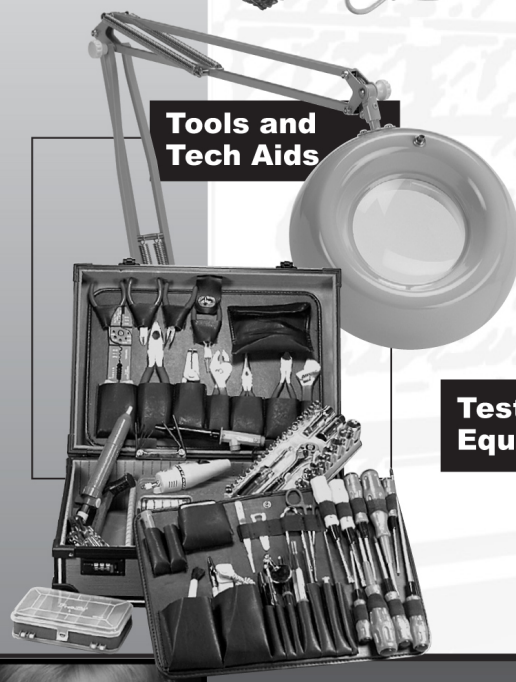

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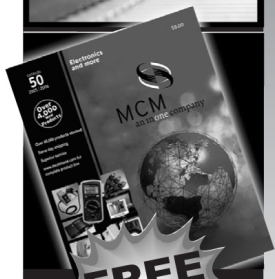

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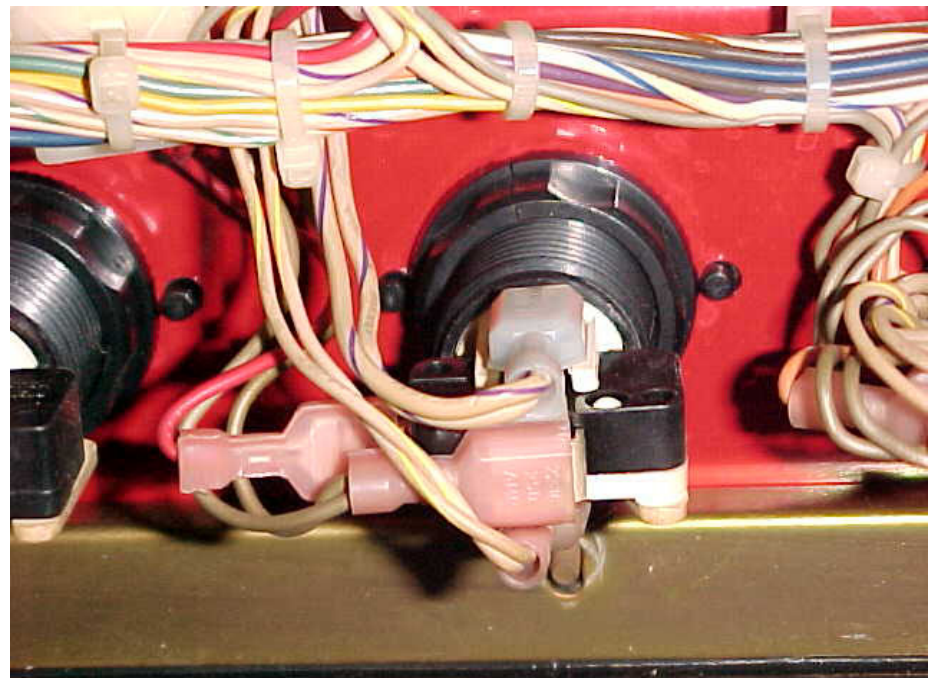
be the button before or the button after. Make sure that ALL of the wires are connected correctly on all of the switches. If the wire that supplies the voltage to the light bulb is connected to the micro switch, that's not good. Even if one of the ground wires is off, it may give you problems.

In the picture you can see the hold buttons, the micro switches, and the wires. One thing I do is compare the color of wire to the button next to it to see that it is proper. This even works on older WMS games. We had one game that wouldn't communicate with our CDS tracking system. There were all kinds of problems with that thing. Communication was only one of them. With the wire that was suppose to be connected to the button light bulb connected to the micro switch, it was screwed up. But by not comparing the color of the individual wires, it would be hard to find, because everything was connected.

WMS Bluebird: Problem with the LCD going out.

This was a weird problem with a Bluebird. When you close the main door, the LCD would go out. When the game power was turned off and then back on again, the LCD came back on until the main door was closed. I checked the door wire harnesses for bare or pinched wires; they all visually looked ok. The ground straps between the main door and the slot frame were OK and in place. Even if the door touched the slot frame, the LCD would go black. Ok, looks like we have stray voltage somewhere. I also noticed that on the back plane board, all of the voltage lights were on when the LCD was on, but when it went out, I lost the majority of the voltages. Reboot the game, and they would come back. Maybe it could be a bad power supply? I changed it out, closed the door and out it went again.



Make sure that ALL of the wires are connected correctly on all of the switches. If the wire that supplies the voltage to the light bulb is connected to the micro switch, that's not good.

Then I started to disconnect things such as the interior light, the button harness, and the belly light harness, etc. I have the button harness, the belly light, the interior light and a couple of the door ground straps disconnected and still, it goes out when the door is closed. Back to the drawing board. Maybe I need to use the meter and check to see if there are pinched wires in the door hinge. A job for tomorrow morning.

I go in the next day and my manager tells me that the game is up and running. The coin diverter solenoid was shorting on the door. Well, that explains it. Since the game is coinless, there isn't a coin comparator, only the diverter coil, why would it screw up the LCD? I guess it was touching on the doorframe and when it was closed, it would take out the power supply. Luckily when the power supply senses too much of a load or a problem, it shuts itself down. A fellow tech found the diverter problem, straightened it out, and the game was back in play.

- Pat Porath
- pporath@slot-techs.com

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Slot Tech New Products From Sencore

VP401 Multimedia Video Generator

Sencore introduces the VP401 "VideoPro" - a portable video generator for testing and aligning gaming and casino video displays

The VideoPro delivers the tests signals you need to test, align and repair gaming monitors including CRT, LCD, projectors and plasma displays in all operating modes.

Until recently connecting and applying a video test signal to a gaming/casino monitor was a complicated task . . .

Today's CRT color gaming displays require analog RGBVH input signals via specialized connectors and are capable of operating in different resolution formats. New LCD gaming monitors use 15 pin VGA signal interface connectors and DVI (Digital Visual Interface) connectors. Other casino displays, such as plasma and projection systems use YPbPr signals and connections.

The Sencore VideoPro, model VP401, provides test signals to standard VGA and DVI inputs and to specialized input connectors using available adapter cables for all testing, alignment and troubleshooting applications.

Gaming displays have increased in resolution formats offering VGA and SVGA equivalent performance. Newer and higher resolution formats are needed to test these gaming displays duplicating the game's video signal. The "VideoPro" provides selectable resolution formats (640 X480, 800x600 etc) to test all gaming and casino floor displays.

Color Monitors require proper alignment for a consistent casino floor appearance. Innovative video test patterns and alignment techniques offered by the "VideoPro" insure precision adjustment of display focus, color, brightness and contrast resulting in the best casino floor game appeal.

It's now a snap to determine if the problem is the game or display on the casino floor. The VideoPro is lightweight, portable and battery operated with approximately 8 hours on a single charge.

See sencore.com for details

Sencore Introduces the CP5000 Laptop and CP5001 Pocket PC All Display "ColorPro" Color Analyzers

The CP5000 laptop or CP5001 Pocket PC "ColorPro" analyzers are light and color analyzers ideal for professional display calibration of all video display technologies including CRT, LCD, plasma and projection displays. The performance specifications of the ColorPro analyzers mean you can calibrate video display anywhere with lab grade or professional broadcast accuracy.

Improper video display adjustments can result in incorrect picture clarity, color, hues and brightness, making a video game less appealing to play.

In addition, variation or inconsistency in video display adjustment or calibration causes each display to look drastically different, resulting in an undesirable variation of display quality. Professional display calibration, including precision color balancing and luminance adjustment with the ColorPro, provides consistent display calibration and gaming video screens.

Calibration is easy with the ColorPro. Analyzing software combined with a screen light/color sensor provides measurement analysis. An easy-to-use-and-interpret software user interface greatly decreases calibration time with easy-to-follow CIE and RGB measurement screens including adjustment instructions. You know exactly which colors need adjusting.

A luminance (Y) light measurement provides an accurate reference for establishing light output levels for black level and brightness consistency among gaming displays. Furthermore, the luminance measurement is effective in detecting differences between top and bottom picture light levels, caused by burned-out backlight bulbs in LCD display monitors.

The ColorPro software provides report capability for documenting test results and performance of each display calibrated. Report data can be saved to PC memory (CP5000) or downloaded to a PC (CP5001). Either ColorPro model comes supplied with an attractive, durable carrying case for protecting your instrument between jobs as well as a 30' extension cable and tripod mounting bracket.

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EHT TOVIS
An Introduction to Digital Monitors - Pt 8

We will conclude our eight part look at the Tovis digital monitor with the EHT circuit.

As discussed in part seven, the drive signal for the EHT is the same as the horizontal drive signal. This means that the operating frequency of the EHT circuit is always synchronized to the horizontal deflection. In a somewhat similar way, the operating frequency of the SMPS is also tied to the horizontal frequency, though not through the horizontal drive signal but rather through the AFC (automatic frequency control) output of the flyback transformer.

This synchronicity is important in order to minimize interference between the various circuits such as the video, power supplies and deflection. If they're all operating at the same frequency and phase, they won't interfere with each other. Anything noisy (such as switching) occurs during retrace or at the extreme edge where it isn't visible.

The synchronous design also allows electrolytic filter capacitors in power supplies to degrade pretty badly before any symptoms become visible. It is not unusual to see these capacitors severely bulged out on the top or otherwise wiped-out (such as being almost totally open) and yet no symptom was visible until the monitor finally failed at the very end. The capacitor didn't fail overnight. It generally takes months or years to kill an electrolytic capacitor. Surely, the monitor had been operating for months with marginal capacitors but regardless, it had been working perfectly well.

EHT – Extremely High Tension

But I digress. Let's get back to the EHT. The "extremely high tension" is the very high voltage that is applied to the second anode of the CRT. However, when discussing this circuit, we include everything that is in and around the flyback transformer - including any and all flyback transformer/HV unit outputs such as those used for the screen, focus and control grids in the CRT itself - as well as things like automatic beam limiting (ABL) and dynamic focus. What we're really talking about here is everything that controls or powers the CRT, with the exception of the cathodes themselves (they are controlled by the video circuits) and, arguably, the 6.3 volt CRT heaters that are powered by the SMPS (although in some monitors – not Tovis – the 6.3 volts for the CRT heater DOES come from a low-voltage secondary winding on the flyback transformer and in such cases is included in the EHT circuit as well).

Picking up where we left off at the end of part seven, the horizontal drive signal is applied not only to the horizontal deflection circuit but to the EHT circuit at the base of Q307 as well. The inverted EHT drive signal appears at the collector of Q307 and is directly coupled to the following stage, comprised of Q309 and Q310. This is another "complimentary, single-ended, push-pull" circuit as discussed in part seven.

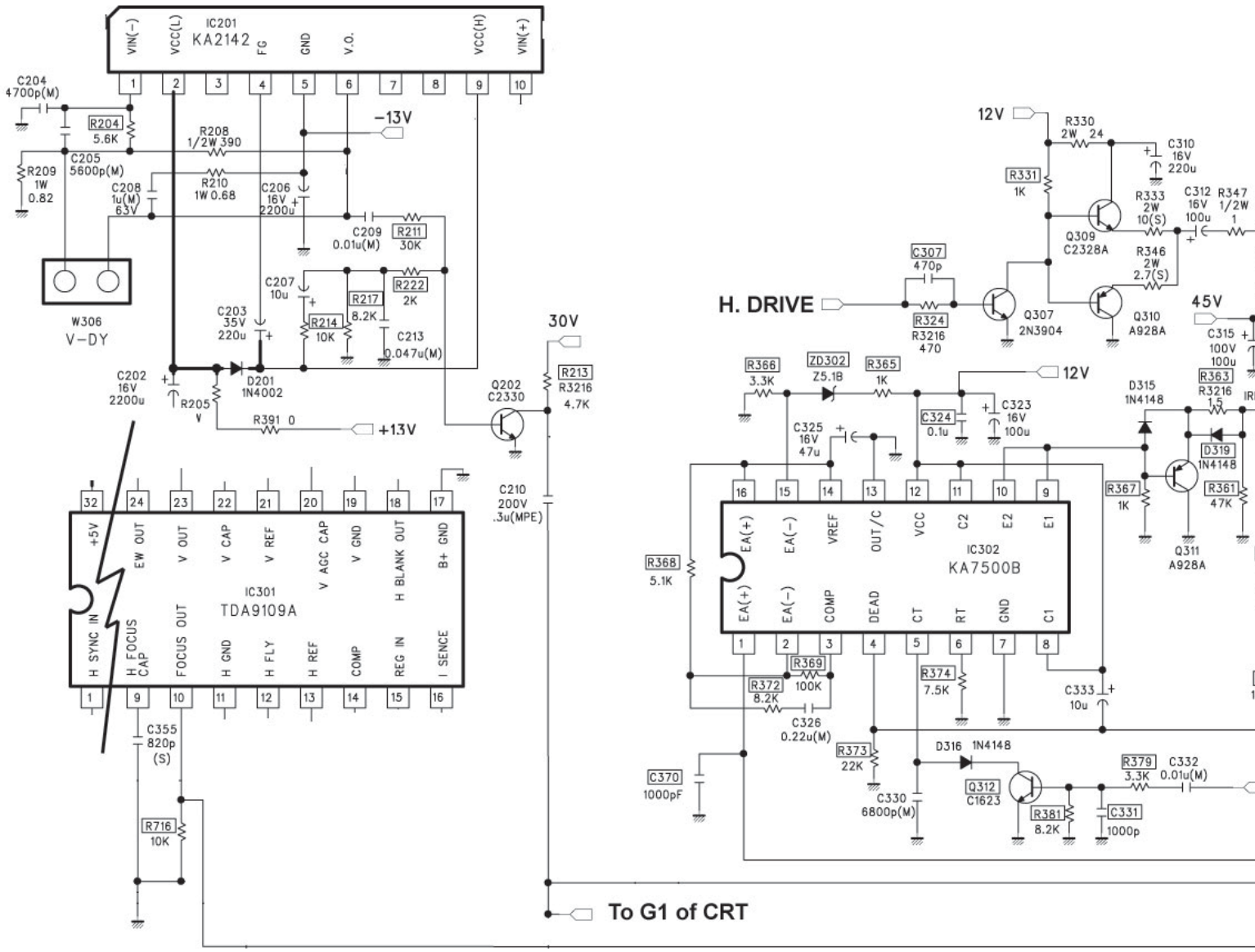
The output of this circuit is capacitively coupled to the base of the EHT output transistor, Q319, a type KSC5386. This is the transistor that we would normally consider to be the horizontal output transistor in a tradi-

tional monitor design (are we now going to refer to this transistor as the EHTOT or the E-HOT or something?). This transistor includes the internal damper diode and the snubber resistor between the base and the emitter. It's rated at just 8 amps, where the actual horizontal output transistor in this monitor (Q308, an FJL6820) is rated at 20 amps. The difference serves to illustrate the higher current required by the horizontal deflection coil(s) in the yoke as compared to the EHT primary, a difference that wasn't readily apparent when the two circuits were combined in the designs of monitors past.

It is significant to note the capacitive coupling between the drive signal and the base of Q319, provided by capacitor C312. If anything in the previous drive stages were to fail in such a way that the base of Q319 received a continuous DC voltage of as little as six-tenths of a volt, the transistor would remain continuously turned on. Depending on just how much the transistor was turned on (whether the transistor was completely turned on – saturated – or only partially turned on, operating in its resistive "linear" region) the SMPS would be overloaded and go into OCP shutdown (tick-tick-tick) or the transistor itself would be destroyed. By capacitively coupling the drive signal to the output transistor, any unwanted DC is blocked because a capaci-

tor cannot pass DC. A capacitor can only pass AC. As long as the drive signal is putting out AC (at the same frequency as the horizontal deflection, of course) the drive signal passes right through the capacitor to the base of the EHT output transistor. However, if anything fails and the EHT drive turns into DC (even if it's shorted and putting out the full +12 volts DC) the EHT output transistor just sits there in a turned-off state with its base voltage at zero because the DC can't get past the capacitor. In older designs, this same function was accomplished by the horizontal drive transformer which likewise will pass only AC and will not pass DC.

Hanging off the collector of Q319, you'll find the typical 1600 volt polypropylene capacitor. In this case it's 1000 picofarads. In traditional designs, we would refer to this as the "retrace tuning capacitor." I have also heard (and seen) reference to this as the "safety capacitor" as its value is (was) critical to the output voltage of the flyback transformer. In this case, the "safety" to which the term refers is that of X-Ray hold down. If this critical component changes value, the monitor can emit excessive X-Rays. Normally, the only thing that causes excessive X-Radiation is an SMPS failure that causes an over-voltage condition. Completely unrelated to our discussion of the Tovis monitor (but something of which you should be aware) is that this



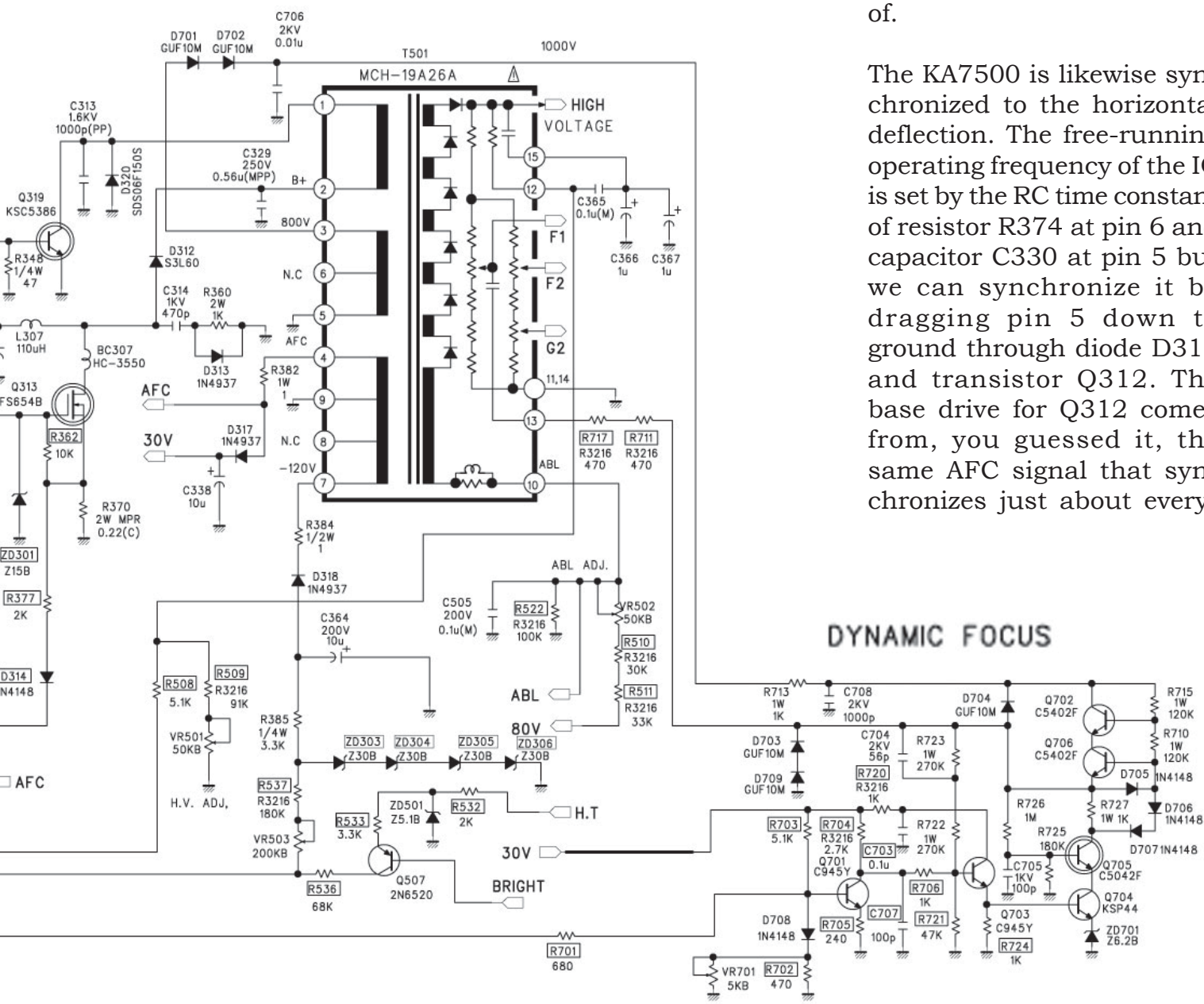
is the reason that we always look at a secondary output of the flyback transformer in order to detect an X-Ray condition and not the output of the SMPS, despite the fact that 99% of the time, X-Ray protection is activated due to SMPS failure. With something as critical as X-Ray protection, we have to be 100% accurate.

Just as it is in traditional monitor designs, the collector load of the output transistor is the primary winding of the flyback transformer. You can see that the collector of Q319 is connected to pin 1 of the flyback. The source for the primary current is the B+ power supply. It's connected to pin 2.

EHT Regulation

The B+ is a boosted supply, just as we saw in the horizontal output circuit. The +45 VDC power supply is boosted to +90 VDC by the circuit comprised of switching MOSFET Q313 and coil BC307 (where the energy is stored) along with the associated driving circuit (Q311) and the PWM controller IC (IC302) a KA7500. Anyone familiar with low voltage switching power supplies is familiar with this IC as it can be found in millions of the computer power supplies that have been built in the past couple of decades. The Fairchild KA7500B is functionally identical to Texas Instruments' TL494, Fujitsu's MB3759, Sharp's IR3M02 and likely a half-dozen others that I have never heard of.

The KA7500 is likewise synchronized to the horizontal deflection. The free-running operating frequency of the IC is set by the RC time constant of resistor R374 at pin 6 and capacitor C330 at pin 5 but we can synchronize it by dragging pin 5 down to ground through diode D316 and transistor Q312. The base drive for Q312 comes from, you guessed it, the same AFC signal that synchronizes just about every-



thing else. Notice that the AFC signal is capacitively coupled to the base of Q312 through capacitor C332, giving us just the wee pulse we need to turn on transistor Q312.

But why do we need this boost supply when we already have a perfectly good, regulated +45 VDC output from the SMPS? Using the boost supply gives us a very important advantage. It allows us to regulate the EHT in ways that we never could with traditional monitor designs. It's really not so much the higher voltage that we're looking for here, it's really the ability to modulate the B+ that works to our advantage because that's how we regulate the EHT output of the flyback. If the EHT drops during an increase in beam current (as the displayed image changes from a dark screen to a bright one, for example) the boost circuit responds by increasing the pulse width, thereby increasing the primary voltage and jacking the output voltage up accordingly.

Another way to look at it is this: If the screen is really bright, with all three electron guns going at full tilt, there are trillions of electrons being pumped into the CRT. What goes in must come out and, after striking the phosphor-covered glass screen of the CRT, they come out the second anode. The EHT is positive and the electrons, being electrons, are negative. The positive EHT is like a powerful vacuum hose, sucking out the negatively charged electrons. There has to be enough suction to remove all of the electrons. None of the electrons can be left behind. If there are any electrons left inside the CRT, they will form a negatively charged cloud in the bell of the CRT. This will interfere with the electron beams and cause them to diverge toward the outer edges of the CRT. It's a phenomenon called "blooming." The raster becomes too large for the screen and the image will be dim. Focus may also be affected to some degree as well.

By using our modulated boost supply, all we have to do is to monitor the flyback transformer output at pin 12 and "PWM" the boost circuit accordingly. Pin 12 is obviously not the EHT output. This is a low voltage, DC output that samples the EHT as you can see from the schematic diagram. In most EHT monitoring schemes, we simply look at a low-voltage secondary winding on the flyback transformer. In this case, we're really sampling the actual EHT after it has been rectified and everything. Sweet. Now we can have very precise control of the EHT. The output at pin 12 is passed through a pair of voltage divider resistors (R508, R509) and the high voltage adjustment potentiometer (VR503) to the voltage comparator input of the KA7500 at pin 1. The IC compares this voltage to the reference voltage at pin 2 and, if the EHT is too low, it boosts the output pulse width at pins 9 and 10 (the two are tied together as it is configured for single-ended output in this application). The wider pulse translates to a higher boost voltage on the primary winding of the flyback transformer and the secondary follows suit. Likewise, if the EHT is too high (such as when all of the electron guns are cut off) the IC will sense that and cut back on the pulse width, lowering the EHT. Of course, the EHT doesn't really fluctuate at all as the entire EHT circuit is operating at the horizontal frequency and so the EHT is actually being corrected on a line-by-line basis. On a monitor operating at 800 X 600 resolution, the EHT will have been sampled and corrected 600 times each field or 48,000 times each second. This gives as a rock-steady raster size, regardless of changes between dark and light screens and, since focus is derived from the EHT, it maintains razor-sharp focus as well.

Dynamic Focus

But we're not done with focus. Not by a long shot. We still have one more very important consideration in this regard and it's something we touched on in part seven. Do you remember how we had to use parabolic correction (E/W Correction) in the horizontal deflection in order to correct for "pincushion?" Do you remember why? It is because modern monitors have flat rather than spherical CRTs

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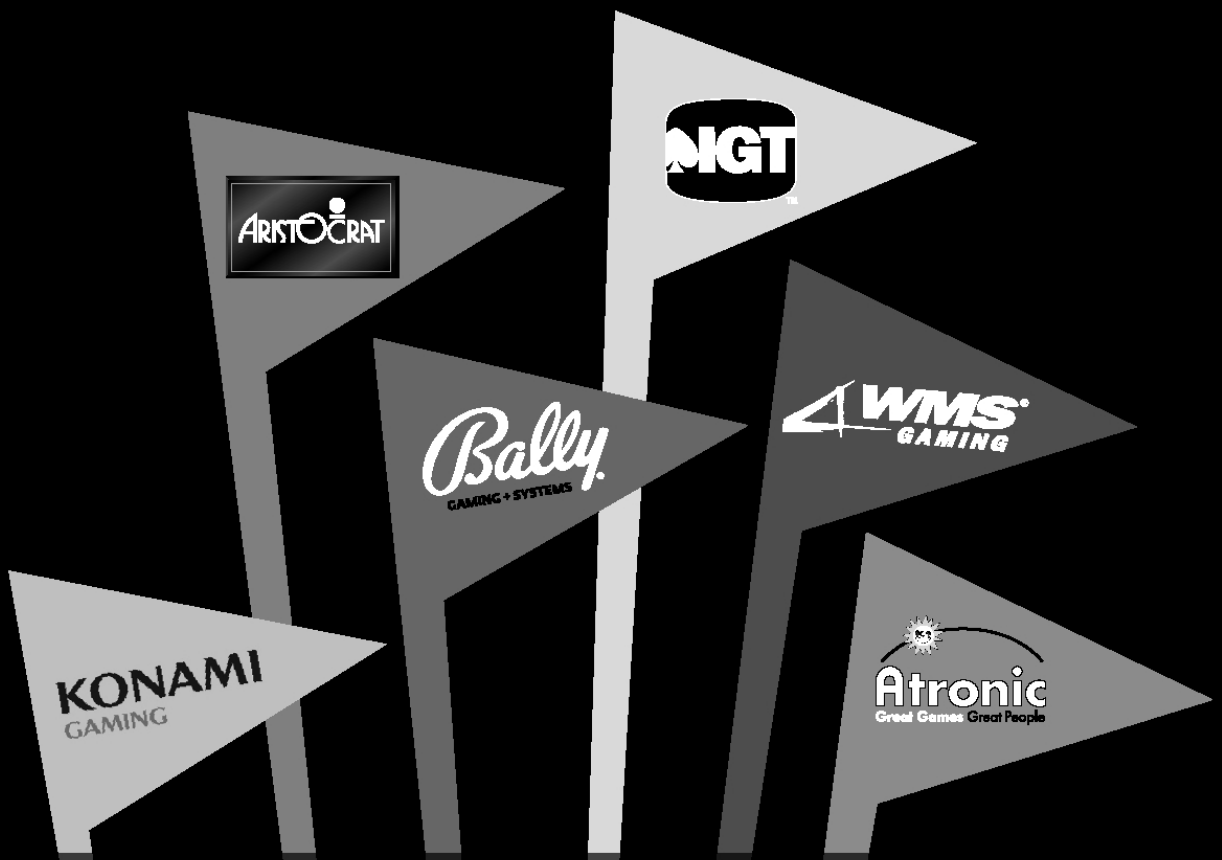

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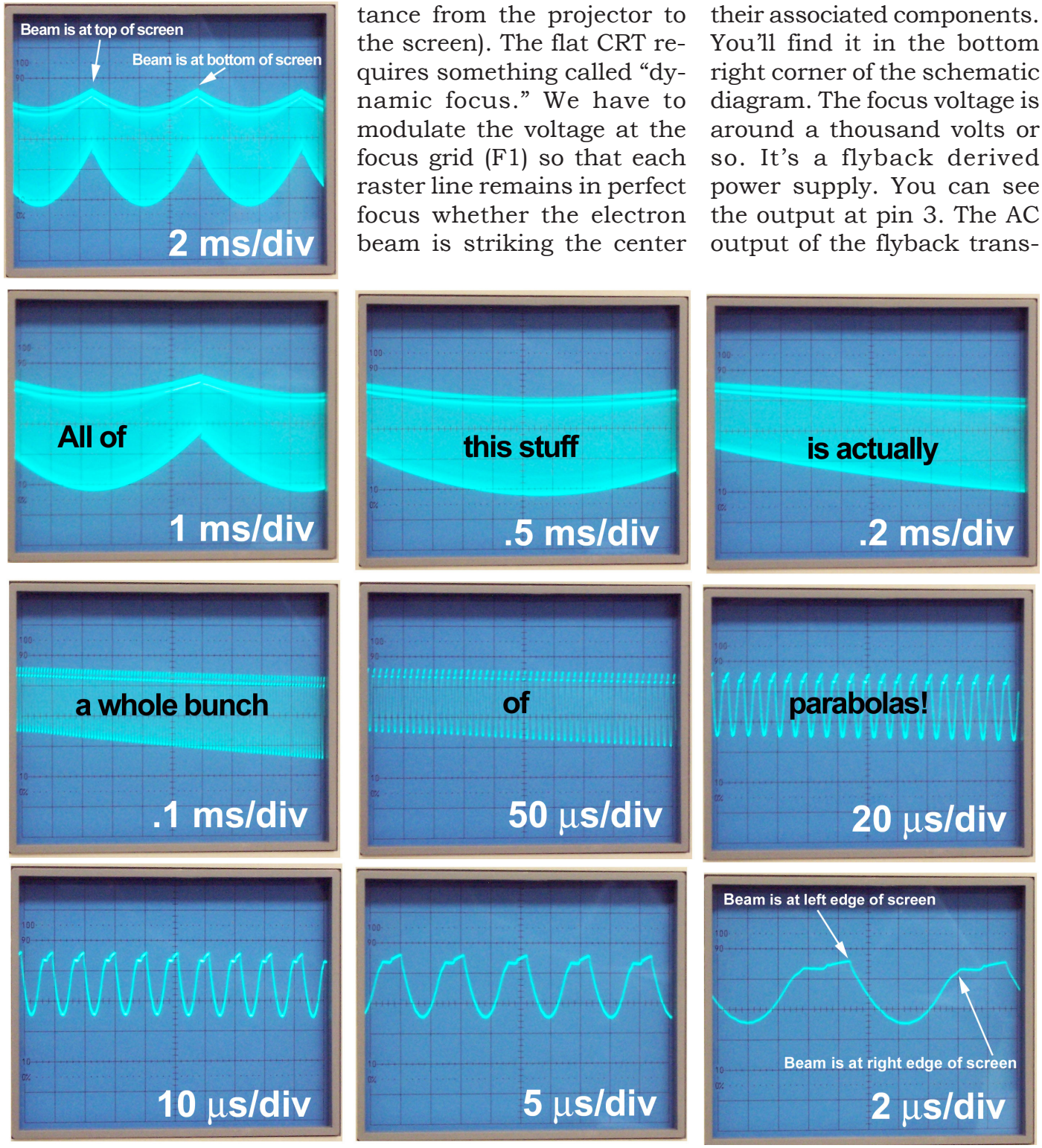
and the distance from the electron guns to the edges of the CRT is greater than the distance from the guns to the center. Likewise, focus is determined by distance (think about setting up a slide, movie or video projector and how the size of the image changes AND you have to refocus if you change the distance from the projector to the screen). The flat CRT requires something called "dynamic focus." We have to modulate the voltage at the focus grid (F1) so that each raster line remains in perfect focus whether the electron beam is striking the center (where it is the closest), the edges or the corners where the distance is the furthest.

The dynamic focus circuit consists of Q701 – Q706 and their associated components. You'll find it in the bottom right corner of the schematic diagram. The focus voltage is around a thousand volts or so. It's a flyback derived power supply. You can see the output at pin 3. The AC output of the flyback trans-



The dynamic focus signal consists of a parabola within a parabola. You are looking the same signal here as the horizontal timebase of the oscilloscope increases in speed from two milliseconds per division (top left) where you can see three fields displayed to two microseconds per division (bottom right) where you can see the focus correction parabola for two lines.

former is rectified by D701 and D702 (in series, to double the voltage rating over that of using just a single diode) and filtered by C706 to create a +1000 volt DC power supply.

In a nutshell, we need to modulate a relatively high voltage here (at least as far as transistors are concerned) and to do that, we're going to have to use a bunch of transistors and sort of put them in series too, just like we saw with D701 and D702. Putting things in series means that the voltage drop can be shared by, in this case, four transistors. Each transistor takes its share in dividing the voltage, which is subsequently output at the node that is most easily identified on the schematic diagram as the anode of diode D705 (it's really the junction of the emitter of Q706 and the collector of Q705 that is the actual output of the voltage divider).

The magic signal that controls this dynamic focus circuit is connected to the base of Q701 (which makes a lot of sense as the base is the controlling input of a transistor) and it comes from the focus output of IC301, the TDA9109A with which we are familiar from previous discussions about the Tovis digital monitor. What could be simpler? The TDA9109A is our sort of "everything controller," itself under the command of the microcontroller through the buss. The focus output is another of

IC301's functions. And guess what . . . It's a parabola! Is that really such a surprise? It shouldn't be. We used a parabola for E/W correction and the same thing applies here. The IC puts out a nice, low voltage parabola and sends it to the dynamic focus circuit which translates the voltage into a high voltage parabola which is then connected to the focus circuit at pin 13 of the flyback transformer.

When the beam is at the left edge of the screen, the voltage at focus grid F1 is at its highest (around 800 volts). As the beam travels from the left edge of the screen toward the center, the focus voltage drops until, when the beam is in the exact center of the screen, the voltage at F1 is down to around 500 volts. The opposite happens as the beam moves from the center to the right edge and the focus voltage rises back up to 800 from 500 volts. This scheme keeps each raster line razor sharp as it sweeps across the flat face of the CRT.

A Parabola Within a Parabola

At this point, some of you are thinking ahead and saying to yourselves "Hang on just a second there buckaroo. Isn't the distance from the electron guns to the screen different between the center of the CRT and the top and bottom edges just as it is between the center of the CRT and the left and right edges? And if so, don't we need to correct for that as well?"

Ok, the word "Buckaroo" probably didn't really enter your mind but you'd be right about needing to add a vertical component to our focus correction. We do and I don't have to tell you what shape it is. The really neat thing is that each of the individual raster lines that make up the field is actually modulated by two parabolas: One is the horizontal component as discussed; the other is the vertical component. Raster lines that are closer to the top or bottom edges have a higher focus voltage than those toward the middle of the screen. With an oscilloscope, you can see this really amazing, dynamic focus waveform in action. When set at the horizontal timebase, you can clearly see the pretty parabolic waveform that modulates the focus grid. As you decrease the horizontal sweep speed of the oscilloscope (increasing the timebase) the vertical parabola becomes apparent. You can see that each of the parabolas for the vertical is modulating a group of 600 (in 800 X 600 mode) parabolas for the horizontal, one per raster line. This is the most complex waveform in the monitor.

G1 - Blanking and Brightness Control

That really leaves only a few odds and ends that don't necessarily come under the heading of EHT but arguably belong in this discussion because they concern flyback-derived voltages and another of the CRT's grids. This time, it's the "control grid" (G1). We can control the brightness of all three guns simultaneously by modulating the control grid. We can even cut them off completely with a negative pulse. The blanking transistor is Q202. You can see how it receives its base drive from the vertical output pin of the KA2142, through capacitor C209 and resistor R211.

Capacitor C210 is charged by the flyback derived, -120 VDC power supply, through resistor R537 and the "sub brightness" potentiometer VR503. The G1 voltage will sit at around -40 VDC during the time that the field is being drawn on the screen. Notice that the other end of C210 is connected to the +30 VDC power supply through resistor R213.

During the vertical retrace time, Q202 is turned on. This completes the return path for capacitor C210 to ground, instead of the +30 volt power supply. Naturally, this causes a 30 volt drop in the G1 voltage from -40 to -70 volts DC. Since the electron beam is negatively charged as well, the further G1 moves in the negative direction, the harder it will be for the electrons to escape from the cathode. The 30 volt drop in voltage is all we need on the control grid (G1) to effectively choke off all three electron beams during the vertical retrace time – Vertical blanking.

Pin 10 of the flyback is the automatic beam limiter (ABL) output. The ABL signal controls the base voltage of transistor Q501 (refer to the schematic printed in part one). The output is taken from the collector and this voltage is then compared by IC501 to produce a "contrast" signal that is subsequently applied to the ABL input of the KA2500 video processor, IC401. In this manner, a base contrast level can be set by the microcontroller and subsequently maintained at a set level, regardless of changes in the image being displayed (bright or dark) and regardless of how the electron gun emission changes over the life of the tube.

Conclusion

If you have been with me since the beginning, you should now have a very good idea of exactly how the Tovis digital monitor works. You will find that most digital monitors follow more or less the same structure, regardless of the manufacturer. You will find some variations on the themes. For example, where Tovis has used boost regulators for the horizontal output and the EHT circuits, other manufacturers use something called a "buck" regulator that lowers the voltage rather than raising it. These are just two different ways to accomplish the same goal, that of being able to modulate the supply voltage. You'll see variations in SMPS design as well but the differences are slight and troubleshooting is really identical regardless. Likewise with all of the other circuits. There are slight differences but once you understand the basics of each of the sections, they all fit together nicely.

One of the keys to successful monitor troubleshooting is having the proper documentation. A large collection of schematic diagrams is available for free downloading at the website at slot-techs.com.

My thanks to Tovis for their donation of a monitor to the Slot Tech Magazine laboratory and to Sencore for the use of their remarkable SC3100 Waveform Analyzer.

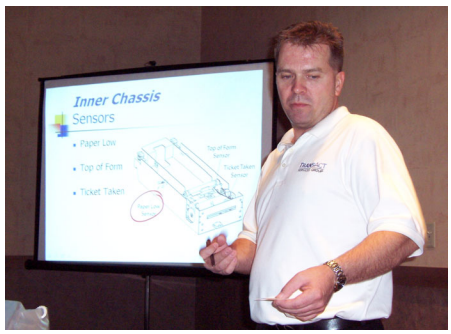
- Slot Tech Magazine

TechFest 12 - Sold-Out in Nice, CA

Fifty-six slot techs from 17 properties attended TechFest 12, sponsored by Robinson Rancheria Casino in Nice, California

David Oldham of Advanced Electronic Systems, Inc. addressed the group as the first guest presenter at TechFest 12, held at Robinson Rancheria Casino in Nice, California. David presented a technical look at MEI's Cashflow SC66 bill validator and the FutureLogic printer.

Sencore was represented at TechFest by Kristel's Ray Holdren. Sencore also awarded a digital multimeter as a door prize. The winner was Lila Paterson of Chinook Winds Casino.



Transact Technologies' Russ Wige discussed troubleshooting and calibration of their Ithaca brand thermal printers.

Jack Geller of JCM discussed cleaning and calibration procedures for WBA bill validators as well as repair issues. He also covered JCM's new UBA (Universal Bill Validator).

Coin Mechanism's Michael Harris presented Coin Comparators as well as a look at their CCFL lighting products for slot machines.

Paul Alexander of Ceronix took us through detailed circuit descriptions and troubleshooting procedures.

Wells-Gardner's Chuck Rabiola presented troubleshooting techniques for the W-G monitors. He also produced a really excellent troubleshooting guide for their monitors, including the U3000 and U3100 models. Each person in the class also received a CD-ROM full of schematic diagrams and troubleshooting guides.

Wells-Gardner also gave away two of their really nifty pattern generators for testing monitors. Pictured above are (l.) Anthony Long of Apache Gold Casino Resort and Ray Stogher of Konocti Vista Casino with Chuck.

Michael L.Gomez, Sr., Michael Gomez, Jr., Ray Stogher, Ray Johnson, Konocti Vista Casino, Jan Albertson, Twin Pines Casino, Lila Paterson, Darrell Schroeder, Chinook Winds Casino, George Frank, SHO-KA-WAH Casino, Harry Vetterolf, Christopher Henseler, Kathryn Payne, Nooksack River Casino, David Sweeney, Diamond Mountain Casino, Jacob "Jake" Fogal, Diamond Mountain Casino, Anthony Long, Lenny Schurz, Apache Gold Casino Resort, David Hernandez, Joe Delmenica, John Degler, Lucky 7 Casino, Eric Denny, Cactus Jack's Casino, Mary Lopez, Andrew Rilla, Gilbert McCreath, Sonny Manzano, Michele Orton, Dan Lopez, Manuel Valadez, Rowland Rave, Charles W. Carver, Daniel Fernandez, Robinson Rancheria Casino, Henry George, Coleville Tribal Casinos, Ruben Saldivar, Phil Degenhart, Art Wong, Richard Rance, Dave Abayan, Chumash Casino Resort, Leobardo Munoz, Angelo Guico, Sandia Casino, Gloria Jim, Darrell Sampson, Rose Shike, Raymond Herrera, Roger Steen, Jeff Funhouser, Yakima Legends Casino, Micah Dickey, Tim Kennedy, Spirit Mountain Casino, Jason Halstead, Tate Vallem, Yolanda Williams, Herwanna Williams, Rusty George, Sapsis Moses, Ken Kipp, Aaron Davis, Clearwater River Casino, Manual Ogden, Clayton Taylor, Eagle Mountain Casino

U3000 VGA/SVGA Theory of Operation & Troubleshooting Guide - PLUS - U3100 Troubleshooting Guide

By Chuck Rabiola - Wells-Gardner Electronics

Let's start off by taking a look at the switched-mode power supply. AC power is converted to DC by a bridge rectifier consisting of D101, D102, D103 and D104 and by filter capacitor C105. Start up voltage for U101 is supplied through R102 and R103. U101 oscillator frequency is determined by the values of R116 and C116. Pin 6 of U101 provides a square wave output to drive the switching MOSFET Q101. The switching action of Q101 generates a square wave using the primary of T101 as a load. A network consisting of C106, R104 and D107 acts as a snubber to prevent voltage spikes generated during switching from reaching levels that could damage Q101. Power is transferred to the secondary windings through the transformer action of T101. Voltages from the secondary windings are rectified and filtered providing output voltages to supply the monitor.

Voltage regulation is achieved by sensing the output voltage of a tertiary winding on T101. The voltage on this winding is rectified and filtered by D112 and C121 and fed to pin 2 of U101 through a divider network. This sense voltage varies in proportion to the output voltage and is used to change the duty cycle of the square wave drive to Q101 in order to correct changes in the output voltage. The waveform from the tertiary winding is also fed through D113 and C118 to generate the DC supply voltage for U101.

Current foldback is used to protect the supply from excessive load current. The current through Q101 is sensed at R108 and a proportional voltage is fed into pin 3 of U101. If the voltage at pin 3 exceeds 0.6VDC, U101 shuts off the output at pin 6. U101 will periodically try to restart; however if the load fault is still present, the supply will continue to go into the shutdown mode. This condition will cause the supply to produce a slight ticking sound.

Sync Decoder Operation

Vertical sync is fed into a pair of Exclusive Or (XOR) Gates (pins 9 and 12 of U302). This circuit configuration will provide a negative sync output at pin 8 for the vertical processor regardless of the polarity of the input signal. In addition, the output at pin 11 will be at a high or low logic level depending on the polarity of the vertical sync signal. This logic signal is fed to pin 3 of the decoder IC U301.

Horizontal sync is fed into pin 5 of a second pair of XOR gates (pin 2 and pin 5 of U302) and is processed in a manner similar to the vertical sync signal. The negative horizontal sync output is provided at pin 6 and the DC logic signal for the decoder IC is provided at pin 3. In addition, the negative horizontal sync is fed to the frequency sensing circuit consisting of U303A and B.

The frequency sensing circuit detects whether a 31.5 kHz (VGA) or a 35 kHz (SVGA) signal is present. Pin 5 is high

for a 31.5 kHz signal (modes 1, 2 and 3) and low for a 35 kHz signal (mode 4). This logic signal is inverted by Q301 and fed to U301, Q302 and Q303. For VGA modes 1, 2 and 3, decoder IC U301 will pull down pins 4, 5 and 6, selecting R319, R320 or R321 to set the vertical size for the detected mode. For the 35 kHz SVGA mode, the outputs of U301 remain floating (high) and Q301 turns on, causing the vertical size to be set by VR318. In addition, Q302 turns on which turns on Q706 causing R746 to become part of the horizontal oscillator RC circuit (in parallel with R710 and VR701). This causes the horizontal oscillator frequency to increase to 35 kHz.

Horizontal Circuit

Horizontal sync from the decoder circuit is applied to pin 1 of U700. The fist section of U700 is an adjustable delay, the delay being determined by the values of C701, R706 and VR700. Adjusting VR700 will move the position of the video on the screen horizontally. The output of the delay circuit is fed to the phase detector which compares the frequency of the sync signal to the frequency of the horizontal oscillator and produces a DC correction voltage to keep the oscillator frequency locked to the incoming sync frequency. The DC correction voltage is fed through R708 to the oscillator. The free running frequency of the oscillator is set by VR701.

High Voltage Shutdown Circuit

The flyback pulse is sensed from the filament winding (pin 9) of the flyback transformer. The pulse is converted to a DC level proportional to the high voltage by D710 and C729. VR702 is adjusted so that when the high voltage exceeds an acceptable level, the internal X-Ray protect circuit of U700 (pin 13) will turn off the horizontal oscillator causing the high voltage to drop to zero. This circuit acts as a latch; therefore power to the monitor must be turned off for a few seconds in order to reset this circuit after it has been tripped.

Video Circuit

Red, green and blue video signals are applied to pins 10, 9 and 8 of P301 and are AC coupled to the video processor IC U200. DC bias for the input amplifiers is provided from the output of pin 11 through R206, R207 and R250. The gain or contrast of the RGB amplifiers is controlled simultaneously by the DC voltage applied at pin 12, which varies with the setting of the contrast control VR201.

DC restoration occurs during retrace when the input signal is at black level. A negative pulse derived from the horizontal sync amplifier

Q205 is applied to the clamp gate input at pin 14. During this pulse, the black level of the signal is clamped to a DC level, which is determined by the setting of the brightness control VR200. RGB output signals from U200 are fed through buffer amplifiers Q200, Q201 and Q202 to the neck board cascode video amplifiers. The outputs of these amplifiers are fed to the CRT cathodes.

Pulling down the video signals to below black level during the horizontal and vertical-blanking periods provides blanking. This is accomplished by turning on Q204 (vertical) or Q208 (horizontal), turning on diodes D209, D210 and D211, forcing the video outputs low. The horizontal blanking signal is derived from the filament pulse, and the vertical blanking signal is derived from the vertical retrace pulse.

Sensing the voltage developed across R801 provides beam limiting. When beam current reaches approximately 800uA, Q800 begins to turn on and Q801 begins to turn off. AS Q801 turns off, the voltage applied to the CRT grid 1 begins to go negative, causing the beam current to limit.

- Chuck Rabiola
crabiola@wells-gardner.com

U3000 REPAIR GUIDE

SYMPTOM	CAUSE	COMMENTS
NO PICTURE/VIDEO	Q102, T701, R802, ZD500, U200, CRT, R727	ADJUST BRIGHTNESS AND CONTRAST. CHECK VIDEO CABLE
JITTER/SHAKEY VIDEO	C115, Q205, Q101, VR701	VR701 DIRTY OR BAD CONTACT
DARK/DIM VIDEO	Q604, U200, R727,	ADJUST BRIGHTNESS AND CONTRAST
WHITE SCREEN	U201, CRT	CHECK SCREEN CONTROL
NO POWER/RASTER	Q101, Q102, Q701, Q700, C106 U101, D106, R101, R727	CHECK FUSE AND POWER CORD
CAN'T SET BRIGHTNESS	Q200, D206, C310, Q102, U200, VR200, CRT	CHECK SCREEN CONTROL AND VIDEO CABLE
CAN'T SET CONTRAST	Q201, D207, C225, U200, VR202, VR201, CRT	CHECK CONTROL BOARD CABLE
NO VERTICAL SCAN	U600, R626, Q600, Q602, Q603	CHECK CONTROL BOARD CABLE
VERTICAL LINEARITY	U600, C612,	
VERTICAL ROLL	R306, U302, VR600, R609	CHECK SIGNAL CABLE
NO HORIZONTAL SCAN	D704	CHECK YOKE CONNECTOR
HORIZONTAL TEARING	Q103, U700, VR700, Q102, Q706	CHECK SIGNAL CABLE AND 2 PIN JUMPERS
HORIZONTAL SIZE	L1, C36, C37, T1, Q705	ADJUST H. SIZE VR704
PINCUSHION	VR703, L701, Q703	
SHUT DOWN	C709, ZD701 (5.6V)	CHECK POWER CORD
IMAGE REVERSED	YOKE CONNECTORS	TURN OFF POWER AND REVERSE YOKE CONNECTOR(S)
NO RED	Q500, Q501, R504, R505, U200, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
RED SCREEN	Q500, Q501, U200, CRT	CHECK NECK BOARD CONTROLS
NO BLUE	Q504, Q505, R524, R525, U200, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
BLUE SCREEN	Q504, Q505, U200, CRT	CHECK NECK BOARD CONTROLS
NO GREEN	Q502, Q503, R514, R515, U200, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
GREEN SCREEN	Q502, Q503, U200, CRT	CHECK NECK BOARD CONTROLS

U3000 Voltage Reference Chart*

PART LOCATION	EMITTER	BASE	COLLECTOR
Q200	2.4	1.69	**
Q201	2.39	1.69	0
Q202	2.4	1.68	0
Q203	0	-1.22	2.2
Q204	0	-0.07	2.21
Q205	0.01	-0.08	4.24
Q301	0	0.8	0.03
Q302	0	**	8.63
Q303	0	0	2.72
Q600	1.19	0.71	23.28
Q601	11.88	11.88	23.25
Q602	11.88	0	11.89

PART LOCATION	EMITTER	BASE	COLLECTOR
Q603	2.1	2.7	12.16
Q604	-0.23	-0.82	-91.25
Q605	6.27	7.12	23.36
Q700	23.32	23.3	1.63
Q701	**	**	**
Q702	0	0.32	4.66
Q703	0.91	1.54	13.63
Q704	14.27	13.62	0.6
Q705	0	0.6	4.44
Q706	11.69	8.57	6.02
Q800	0	-1	-1.4
Q801	-0.77	-1.41	-0.85

LOCATION	ANODE	ATHODE
D200	0.2	12.01
D201	0	0.21
D202	0.13	12.01
D203	0	0.13
D204	0.16	12.01
D205	0	0.16
D206	2.34	1.68
D207	2.34	1.68
D208	2.33	1.68
D209	1.79	2.21
D210	1.78	2.22
D211	1.78	2.22
D301	3.7	5.09
D302	0	3.7
D305	2.95	5.09
D306	0	2.95
D602	1.31	23.2
D603	23.21	23.22
D604	1.36	0.68

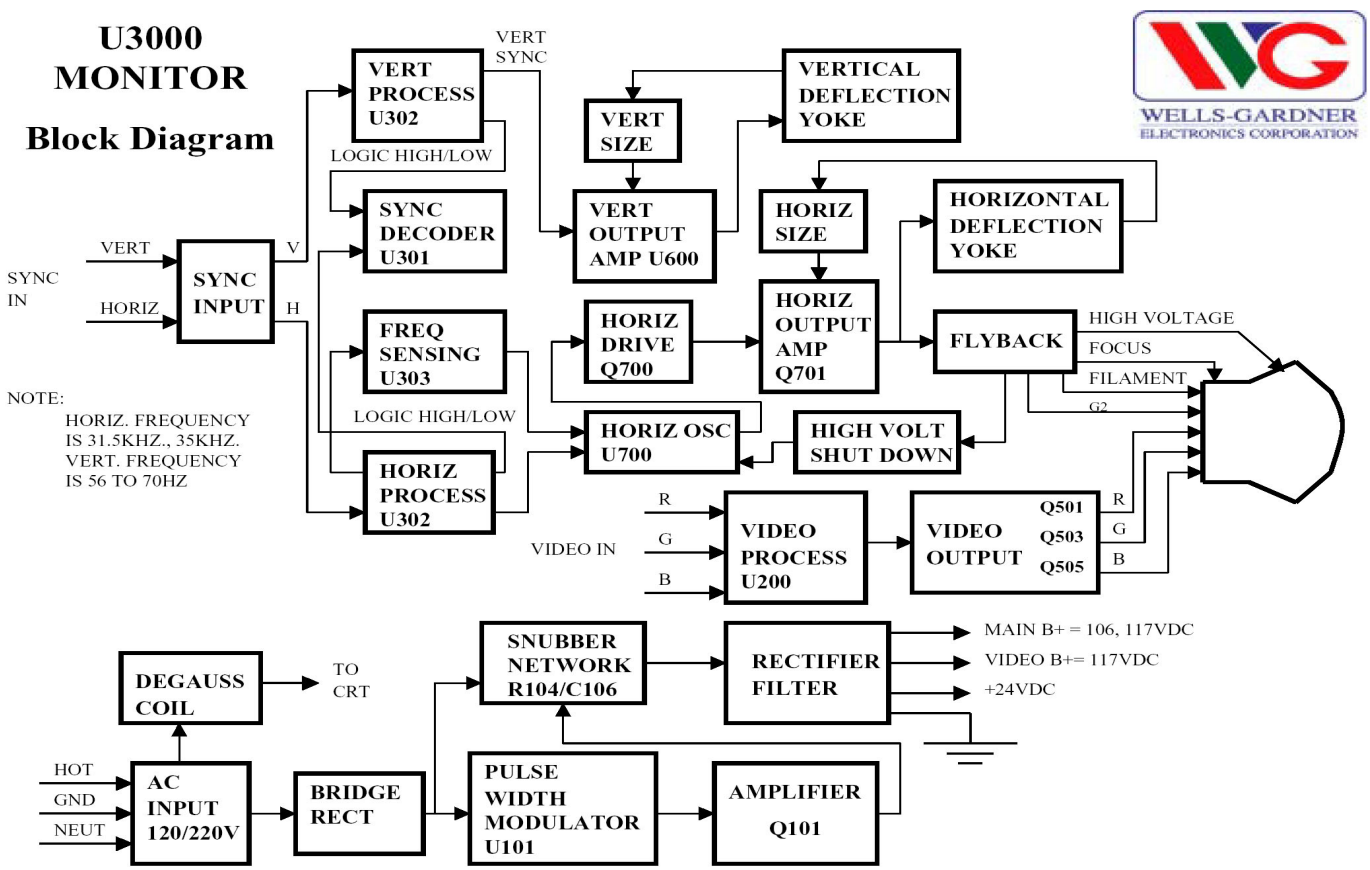
LOCATION	ANODE	CATHODE
D605	0.68	0
D702	23.39	23.37
D704	8.06	104.02
D705	0	8.07
D706	**	
D707	**	
D708	23.39	23.38
D710	0	19.03
D800	-103.3 **	
D801	0	-0.14
D802	-0.01	4.56
ZD301	0	5.08
ZD600	1.35	2.68
ZD700	0	11.65
ZD701	0	3.42
ZD702	-0.2	7.15

*** Voltages are for reference only and may vary with input signal and control adjustments**

U3000 Integrated Circuits

PIN NUMBER	U200	U201	U301	U302	U303	U600	U700
1	12.01	23.39	5.09	0	0.59	6.77	7.52
2	5.56	0	0.03	2.95	5.09	23.28	8.2
3	5.57	12.01	4.37	3.21	0	0.74	8.33
4	2.25		0.14	3.18	0.53	0.16	-0.25
5	2.5		2.79	2.95	3.21	22.94	3.39
6	2.26		2.79	0.59	0	5.54	2.69
7	0		0.36	0	0	5.72	6.61
8	2.48		0	0.13	0	0	6.01
9	2.26		0.35	3.7	0.59	0.08	5.16
10	2.45		0.42	4.38	0.53	1.6	11.67
11	2.32		0.42	4.38	5.09	0.04	5.56
12	5.88		0.44	3.7	0.15	0.05	1.84
13	12.01		3.17	0	4.11		0
14	4.24		0	5.09	0.01		0
15	2.27		5.09		1.45		0
16	2.33		5.09		5.09		0
17	2.24						0
18	0.59						0
19	2.27						0
20	2.34						0
21	2.26						
22	0.59						
23	12.01						
24	2.27						
25	2.34						
26	2.23						
27	0.59						
28	12.01						

*** Voltages are for reference only and may vary with input signal and control adjustments**

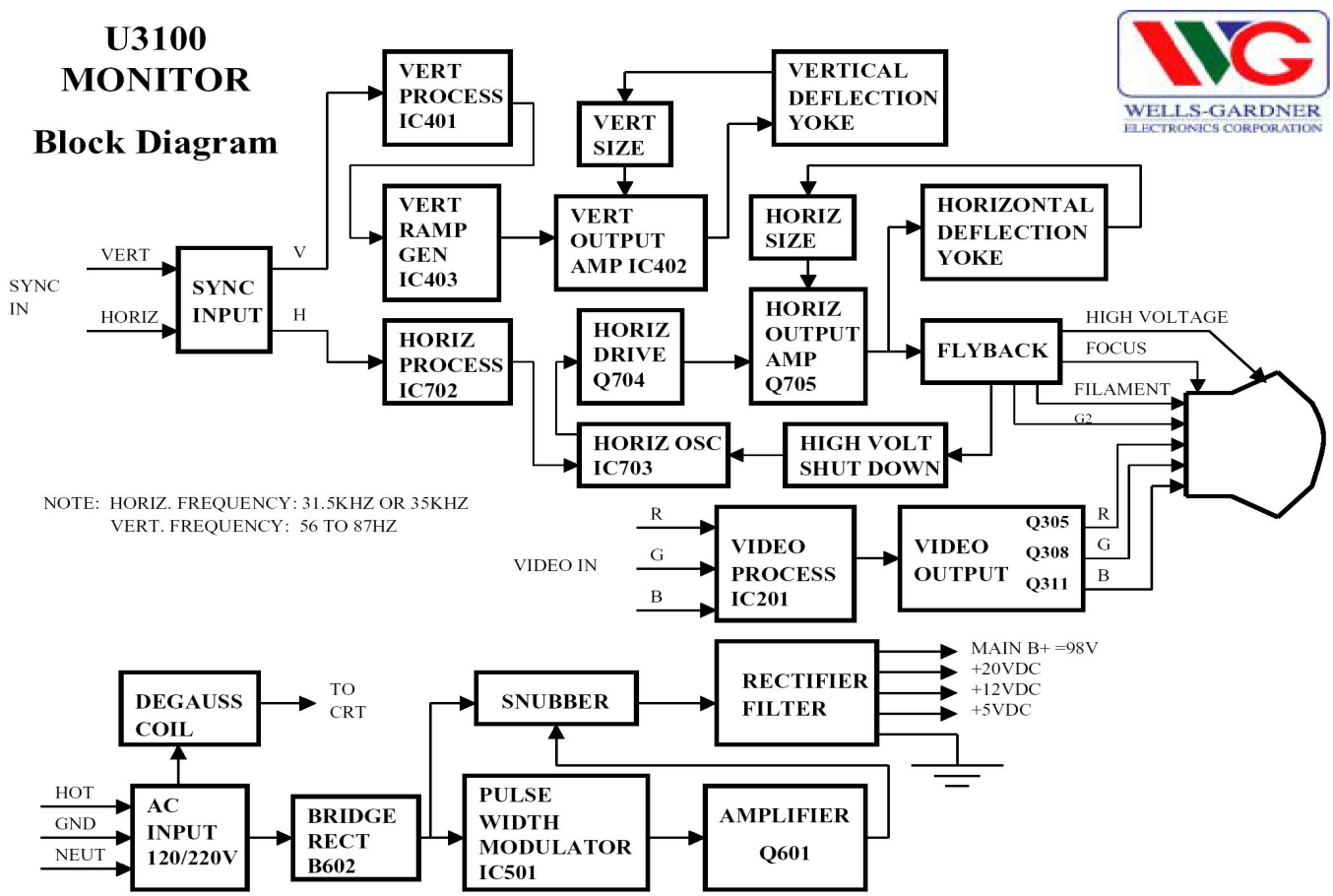


U3100 REPAIR GUIDE

SYMPTOM	CAUSE	COMMENTS
NO PICTURE/VIDEO	IC201, R351, D807	CHECK SIGNAL CABLE
DISTORTED VIDEO	D3, IC201	
JITTER/SHAKES	IC201, C318, C301, C302, C303	CHECK GROUNDS AND VIDEO CABLE
NO POWER/RASTER	Q705, Q704, Q601, D603, D609 T701, T703, VR501, R351	CHECK POWER CORD
CAN'T SET BRIGHTNESS	R815, Q804, C807, R816, D807, IC201, CRT	CHECK SCREEN CONTROL AND VIDEO CABLE
CAN'T SET CONTRAST	R308, IC201	CHECK CONTROL BOARD CABLE
NO VERTICAL SCAN	IC402, D610	CHECK YOKE CONNECTOR
VERTICAL ROLL	J401, IC402	CHECK SIGNAL CABLE
VERTICAL FOLDOVER	R411,	
VERTICAL LINEARITY	C411, C412, IC402	ADJUST V. LIN (VR401)
NO HORIZONTAL SCAN	D2	CHECK YOKE CONNECTOR
HORIZONTAL TEARING	C709, C712, C713, R706, IC703 C714, C715	ADJUST H. FREQ. (VR701), CHECK SIGNAL CABLE
HORIZONTAL SIZE	C3,	ADJUST H. SIZE (VR2)
PINCUSHION	Q1, Q2, Q3, R14, L1, VR2	
SHUT DOWN	C714, C715, C620, ZD701 (6.2V .5W)	CHECK POWER CORD
IMAGE REVERSED	YOKE LEADS	WITH POWER OFF REVERSE YOKE LEADS
NO RED	Q302, Q305, Q306, Q307, IC201, VR302, R17, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
RED SCREEN	Q302, Q305, Q306, Q307, IC201,	CHECK NECK BOARD CONTROLS
NO BLUE	Q304, Q311, Q312, Q313, R19, VR303, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
BLUE SCREEN	Q304, Q311, Q312, Q313, IC201, CRT	CHECK NECK BOARD CONTROLS
NO GREEN	Q303, Q308, Q309, Q310, R18, IC201, CRT	CHECK NECK BOARD CONTROLS AND SIGNAL CABLE
GREEN SCREEN	Q303, Q308, Q309, Q310, IC201, CRT	CHECK NECK BOARD CONTROLS

U3100 MONITOR

Block Diagram



U3100 TYPICAL VOLTAGES WITH INPUT SIGNAL APPLIED*

TRANSISTOR CHART

	COLLECTOR	BASE	EMITTER
Q001	2.7	0.01	0
Q1	0.6	12.3	12
Q2	12	1.6	0.9
Q3	4.5	0.6	-0.01
Q301	11.7	-0.4	0
Q302	8.03	1.8	1.7
Q303	8.03	1.7	1.8
Q304	8.03	1.8	1.7
Q305	73	8.5	8.3
Q306	87	73	73
Q307	0.004	73	73
Q308	73	8.5	8.3
Q309	87	73	73
Q310	0	73	73
Q311	73	8.5	8.3
Q312	87	73	73
Q313	0	73	73
Q314	2.6	14	13.8
Q601	94 AC -D	1.5 AC-S	6.1 AC-G
Q602	98	109	109
Q603	1.08	0.01	-0.02
Q701	7.1	8.3	13.6
Q702	8.01	0.01	0
Q703	0	0.7	0
Q704	13.4	0.4	0
Q705	DO NOT MEASURE		
Q803	22	0	-0.006
Q804	14.7	14.1	14.7
Q805	8.3	8.9	8.2

DIODE CHART

	CATHODE	ANODE
D301	83	69
D302	74	87
D303	72	85
D304	1.8	1.7
D305	1.8	1.7
D306	1.8	1.7
D402	19.8	19.6
D403	0.7	0.01
D404	0.7	4.5
D507	6 AC	6.2 AC
D601	92 AC	6.1 AC
D602	55 AC	1.7 AC
D603	22 AC	1.6 AC
D604	1.6 AC	1.6 AC
D606	3.6 AC	1.6 AC
D607	148 AC	98
D608	98	109
D609	121 AC	70
D609A	70	95

	CATHODE	ANODE
D610	28 AC	22
D611	19 AC	13
D701	-0.6	24
D701A	0.6	0.2
D702	-0.04	-0.041
D801	-9	0.015
D802	-0.007	0.015
D803	-20	-0.004
D804	9.5	8.9
D805	8.9	8.2
D806	-16	87
D807	-149	-21
ZD301	0	8.59
ZD401A	2.5	3.4
ZD402	0	3.6
ZD403	0	4.5
ZD508	1.4	6 vAC
ZD701A	0.6	6
ZD801	0.6	0.2

INTERGRATED CIRCUITS (IC) CHART

	IC201	IC401	IC402	IC403	IC501	IC602	IC701	IC702	IC703
1	13.8	0.1	10.1	0.2	1.4 AC	12 IN	0	0.5	8.6
2	6.6	5	19.7	0.3	1.4 AC	5 OUT	3.6	5	9.1
3	6.57	5	3.6	4.1	1.3 AC		3.1	5	9.5
4	2.5	0.5	0.3	0.2	1.8 AC		3.6	0.3	-0.2
5	2.5	5	-0.01	0.2	1.4 AC		3.1	3	4
6	2.5	0	0.03	0	5 AC		0.58	0	3.5
7	0	1.2	6.7	0	1.5 AC		0	1.1	3.5
8	2.4	0	0	0	1.3 AC		0.1	0	7.1
9	2.56	0.1	4.6	0.7			4.5	0.5	6.9
10	2.36	0.5	5.4	3.1			4.1	0.3	6.8
11	2.61	5	4.4	4.1			4.1	0.5	13
12	9.9	0.1	4.3	4.2			4.5	0.1	7
13	13.8	4.2	0	0.01			0	4.2	0.9
14	11.7	0	19.4	0.01			5	0.01	0.2
15	1.7	1.4	0.9	0				1.4	0
16	1.8	5	0	5				5	0
17	1.8								0
18	0.97								0
19	1.8								0
20	1.8								0
21	1.8								
22	0.8								
23	13.5								
24	1.7								
25	1.8								
26	1.8								
27	0.75								
28	13.8								

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*Voltages are for reference only and may vary with input signal and control adjustments

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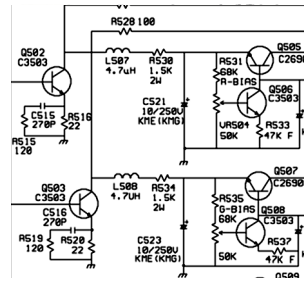
SCHEMATIC DIAGRAMS

Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



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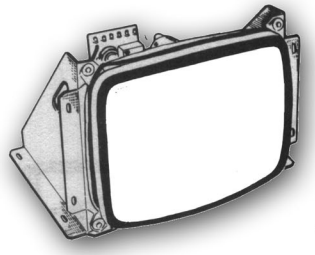
Power supply failure is a common complaint in many different types of systems. Power supply failures are discussed during the class, along with shortcuts for troubleshooting and repairing them.



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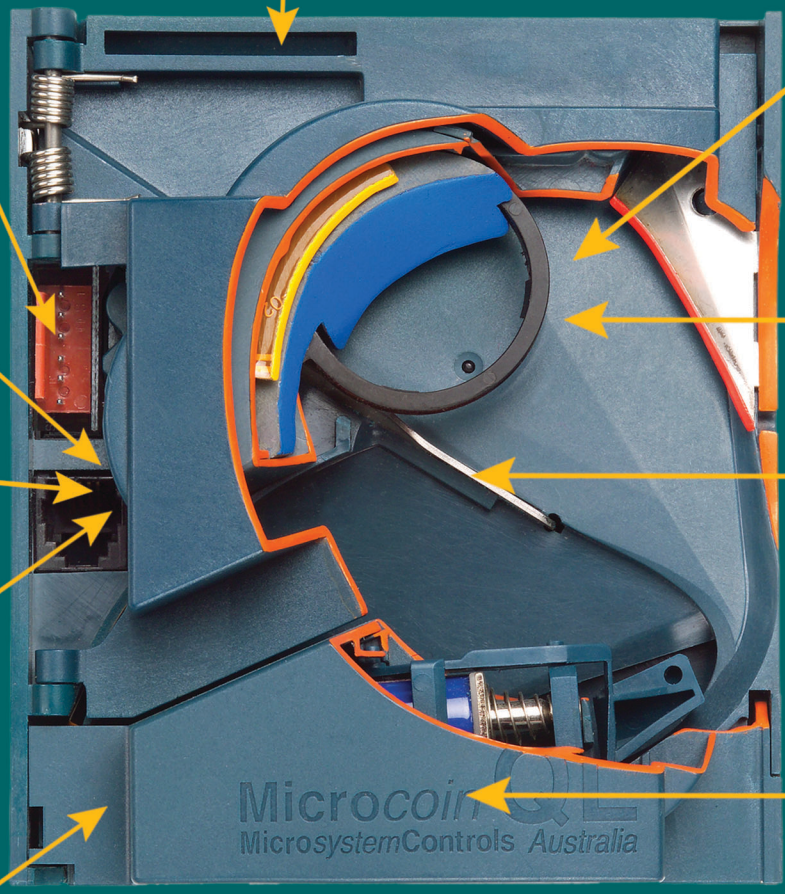

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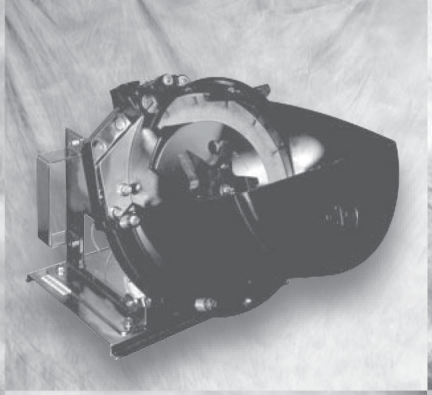
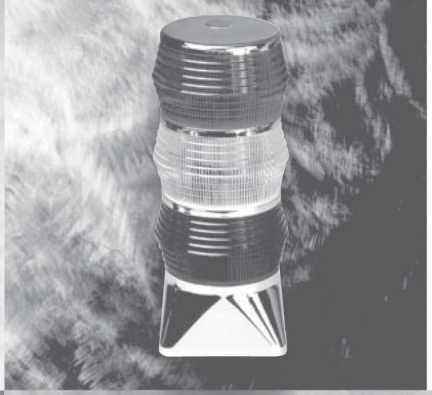

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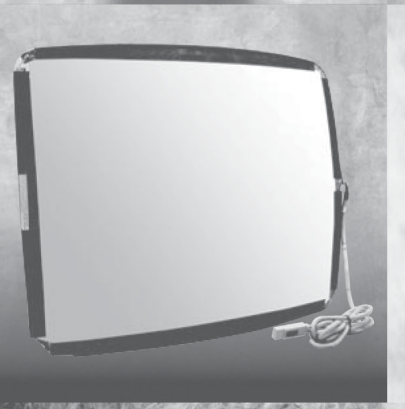


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