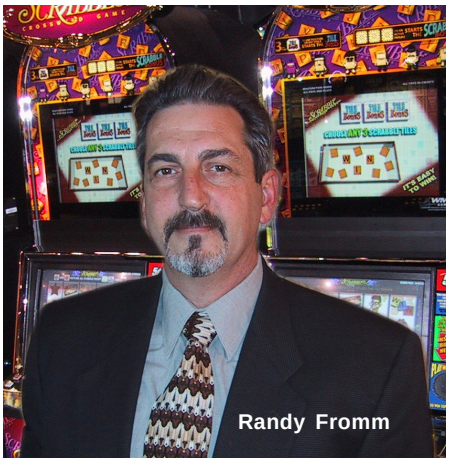
February, 2003

Slot Tech Editorial

In an industry scoop, this month's Slot Tech Magazine presents us with our first look at IGT's new "Advanced Video Platform." I first saw this machine on location at Barona Valley Ranch Casino and Hotel and then, in a weird bit of synchronicity, contributing writer and full-time IGT wunderkind Ken Locke submitted a feature article on the subject that very same afternoon. The Grand High Poobah of IGT wouldn't release any photos of the inside of the game (not by press time, at least) but Ken does an outstanding job of letting us know what's inside and what to expect in terms of the new platform. Turn to page 14.


Randy Fromm

I was recently on a training mission in Okinawa for the Army. On the way over, my flight took me through Inchon, Korea where I was to connect to a flight to Okinawa. The only problem with this was a 12-hour layover between the time I landed in Korea at 07:00 and the time the flight left for Okinawa at 19:00. I had been to Korea a few times already, so I wasn't really interested in doing the tourist thing for the day. Then, in a brilliant flash of inspiration, I realized that one of gaming's well-known suppliers of monitors, Kortek, was based right there in Inchon. In fact, it was right near the new airport (beautiful airport, by the way). I made a few inquiries and before you can say "yoboseyo" I had myself an invitation to take a tour of the factory and see how Kortek makes their monitors. I want to thank everyone at Kortek for their warm reception (despite the freezing weather – Korea gets cold in the winter). I had a wonderful time and a really great lunch. The tour starts on page 18.

Would it surprise you to learn your casino has hundreds or thousands of X-ray machines? Okay, maybe I'm stretching it a bit but in fact, monitors are really just an inch away from being X-ray machines. Read how a monitor can become a radiation hazard and how the X-Ray protection circuit prevents that from happening starting on page 30.

There's lots more as well, including Kevin Noble's look at an IGT S+ to Barcrest conversion, Herschel Peeler on PALs and, as usual, Martin Dempsey's look at Europe.

That's all for this month. See you at the casino.

Randy Fromm

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IGT S+ Conversion to Barcrest

By Kevin Noble

1. PREPARE OLD IGT GAMES AS FOLLOWS:

- Remove reel assembly
- Unplug and remove tower light and fluorescent light harness
- Pull both harnesses down to the middle of the game.
- Remove the four screw which holds the top box on, and remove

1. STARTING THE CONVERSION

- Take the new top box and install on top of game (four screws from underneath)
- Install the mounting bracket from under the MPU 4 to the bottom of the top box. Fasten down the plate with four 6/32" nuts.
- Install fan and large vent cover using four 8/32" nuts. Make sure the fan will be blowing out the top. (plug in the fan harness on the fan before installing)
- Install side vent cover with the chrome outside and the plain plate inside using four 6/32" screws.
- Install the candle on the mounting plate (black plastic wedge) and mount it to the top box with the 2 black hex screws.
- Plug the candle extension harness (orange) on the candle harness and plug it into the original candle harness.
- Run the fan harnesses down the side and plug it into the power harness originally used for the top box fluorescent light.
- Tie all wires around the fan, across the back top, and down the right side corner. This will allow for the MPU not to hit any wiring when it is installed.
- Mount the main harness Beau-plug on the plate with 2 shoulder screws and washers with the notch side down on the right side.
- Run the main harness through the middle hole to the center section of the game.
- Plug the black power cord onto the power supply and run it to the right side corner and down to the lower game section. Locate the games main power supply and plug it into the front left side corner.

NOTES: Some Barcrest games have a button on the on the door that will start the bonus feature. These games will need an extra hole punched out to relocate the existing 2" square "SPIN" button. A small rectangular "SPIN" button and a 6" extension harness will be included in the kit. On the main harness there is a split on the harness. One side has the button harness for the bonus button. This will run out to the door and wired into the bonus button. The new button extension harness will be used to extend the "SPIN" button wires to the new location on the door. The other side of the main harness split will be run from back left to right under the reels.

- Install the interface board on the four posts on the back wall just above the CPU.
- Install the yellow interface harness and the small in line interface wire, and install the in-line filter on the harness.
- Plug one end to the interface board, and run the other end to the motherboard. Locate the SMIB harness, remove it from the motherboard

and plug the "Y" connector into its spot. Plug the SMIB harness and the yellow interface harness into the "Y" connector on the motherboard.

- Plug the small connector on the main harness into the interface board (right side)
- Plug the A/C plug into the main harness to the power supply plug on the left side's unused plug in the front.
- Mount the sound harness plate by removing the plastic drop funnel and placing the plate over top the drop hole aligning the drop funnel screw holes. Remount the drop funnel with the plate harness opening towards the front of the game.
- Run the sound part of the main harness out to the plate and plug it in from the bottom upward with the pins to the front. (red wire to the right) This will line up the speaker plug on the coin tray when installed. Remove the old reel strips and replace with the feature game reels. The reel strip with the feature game symbol will be placed on the third reel while the other two are the same.
- Install the SMIB board behind the reel assembly now.
- Install all the reels and plug them in.
- Remove all the glass and replace with the new theme glass.
- Connect all Mikohn wiring to the SMIB and install the PTM bracket, and chrome front plate.
- Install new CPU board with the already installed game EPROMS. (make sure that the CPU board has the CN2017 upgrade done to it)
- Install the MPU into the new top box.
- You are now ready for the clear and set procedures.

BARCREST CLEAR/SET PROCEDURE

1. Install clear EPROM into SP socket (PE+RAM CLEAR M+ E@ S+ IGT CLEAR)
2. Turn on power, two "0" appear in both corners, press and hold self test
3. Allow winner paid to scroll to 2 _999.
4. Turn power off, remove CPU and install original game SP
5. Turn power on, 61 appear, presses self-test and 61_1 appears. Close the main

door and turn the reset key, 65_3 will appear,

6. Open the door and press self-test again, the game will now spin the reels and wait for game to reset.
7. Install set EPROM in the SP socket, turn the power on and press the self test once
8. 9-0 will appear, change to 1 with the spin button, press self test each time to scroll through the options.
9. Once all you options are set, power game down and install original SP EPROM. Repeat step #5 to clear code.
10. At this point verify all your option is correct.

BARCREST FACTS

- The MPU 4 controls up to a maximum of 128 bulbs
- The "game card" controls the game theme
- There is a separate volume control on the MPU 4
- When installing the beau plug in the top box, make sure the notches face down
- The right side air vent should be installed with the air flow coming in
- The fan should be installed blowing out of the top
- Use the existing tower light with the new top box
- Install the tray connections towards the front
- 64-1 error code, we had two different ways to clear this problem, the white connector was installed backwards on the motherboard, and the game needed a RAM clear and reset.
- The spin button will become the feature game bonus round spin button (large 2")
- The feature button becomes the games spin button (small rectangular button)
- The **"Top Dollar"** and **"Cashbox"** themes does not require any drilling for the feature button
- On the new interface board, the red and green lights will flash together when the MPU 4 and the game are communicating.
- Make sure to install washers behind the beau-plug to allow for the plug to move freely when installing the MPU 4 assembly
- The yellow harness plugs into the interface board, from there it plugs into a filter (each side) and to the motherboard (thru a "Y" connector)
- The "Y" connector plugs into the motherboard, the Mikohn SMIB harness and a yellow harness (2 wires) plugs into the "Y" connector.
- The orange wire is used as the tower light extension
- The 6" harness is used for the new spin button. Disconnect the original spin connections and then plug the extension to the ends, plug the other end to the new spin button.
- **PE+ RAM CLEAR, M+E2, S+ IGT** clear chip is to be used on all themes.
- The **SET 91** can be used on **"PINBALL"**, **"CASHBOX"**, and **"RUN FOR YOUR MONEY"** themes.
- The **SET 62** can only be used on the **"TOP DOLLAR"** theme.
- When clearing the games, two "0's" will appear in the left and right corners. Hold the spin button down until the numbers in the middle start to scroll. The numbers will scroll to 2-999.
- The following "SP's" are used:

1. **RUN FOR YOUR MONEY** – SP1166
2. **PINBALL** – SP1136
3. **TOP DOLLAR** – SP1092
4. **CASHBOX** – SP1191 or SP1192

- There are now a couple of new options used for these games **"OPTION 58**" is the ***"BONUS SOUND VOLUME"*** and **"OPTION 59"** is the ***"ATTRACT***

MODE IN MINUTES"

- The top box also has a test button that allows for testing the game frame
- Self test #22 allow you to test the test modes also
- The power connection for the MPU 4 plugs into the first plug in the back of the main power supply on the left side.
- The fluorescent light power plug is now used for the AC fan
- The reel strips numbers were found to go in reverse order (700, 600 and then 500)
- All the beau-plugs should be mounted on the front of the game frame bracket
- **"CASHBOX"** and **"TOP DOLLAR"** do not require the feature extension button harness
- The **"CASHBOX"** themes frame door hinge is mounted to the top box housing
- The **"CASHBOX"** game frame harness is connected to the MPU 4 LED board located on the left side on the unit.
- The following harnesses are connected, green to top (#1), blue to the third from the bottom (#3), brown on the bottom (#4), and yellow vertically on the left side for the **"CASHBOX"** door.
- The **"CASHBOX"** theme has two beau-plugs; the power supply is mounted on the left, and the door harness, communications to the right, with the key pointing to the right.
- The power supply and the bracket are mounted behind the reels, and the bell needs to be removed and repositioned to this bracket on the **"CASHBOX"** theme only
- The buttons on the new award glass push in and turns about 1/8".
- All three **"CASHBOX"** reel stripes are the same, while the **"PINBALL"** and **"RUN FOR YOUR MONEY"** the special feature symbol is placed on

the third reel only.

- On the **"TOP DOLLAR"** theme the SAS and the address does not require the set chip for setting these options
- 61 codes will be the cause of the cash box in the game not being recognized, or missing.
- The **"CASHBOX"** theme uses the original chop top box as the others require the large extended top box
- The **"CASHBOX"** themes door bracket (left side) must be installed before the game frame can be installed.
- On the **"TOP DOLLAR"** theme the accept button is on the left side, and the reject button is on the right.
- On the **"TOP DOLLAR"** and **"CASHBOX**", the award glass buttons need to connect before the award glass can be installed into the top box.
- The LED board controls all the light functions for the **"CASHBOX"** theme.
- The SMIB board is now mounted below the top box in the lower compartment.

THE KIT PARTS

1. One yellow harness (connects to the interface board and the motherboard)
2. Beau-plug harness (connects to the new spin button, motherboard, tray speaker and interface board)
3. One orange harness (the tower light extension)
4. New top box
5. Tower light shim
6. Fan
7. Air vent cover
8. "Y" connector for power (was not used)
9. Bracket for the self test assembly (was not used)
10. Fan harness (plugs into the harness for that was the fluorescent light)
11. MPU 4 assembly (depending on the theme)
12. Reel strips
13. Feature button
14. 6" spin button extension harness
15. Belly, Reel and Award glass
16. CPU with the EPROMS already installed
17. Hardware including sticky pads, wire ties, and lights
18. Bracket for new speaker connection
19. Tray with speaker assembly
20. 2" button insert decal with the feature game
21. 2" x 4" template card for drilling the new spin button hole

New Self Test Options

Self Test # 22 (Allows you to test the Game frame)

1. Individual light test
2. All lights test
3. 7 segment display test
4. Attract and JP sound test

Self Test # 23 (selection of various options for the feature game)

1. Volume Control Option
2. Light Sequence Option
3. Different Sound Choices

- Press the CHANGE button to activate, and turn the reset key to advance to the next setting (1, 2, or 3) and the SPIN button to advance through each level you want to set.

Self Test #24 (Feature game pay table test "RUN FOR YOUR MONEY)
SPIN – allows you to enter the different rings
COIN PLAYED – indicates the ring #
WINNER PAID – the value in the ring
CHANGE – allows you to select a value

Problems Found and Solutions:

1. **CASHBOX THEME**
   Problem: Status lights blinking green to red and back to green.
   Solution: LED board was defective and needed replacing.
2. **PINBALL THEME**
   Problem: Constant 64-1 error codes
   Solution: Red and Blue harness was not seated correctly on the MPU'S game board.
3. **ALL THEMES**
   Problem: -12 volt LED missing
   Solution: Game frame unit in the top box was not making a good connection with the Beau-plug

4. **ALL THEMES**
   Problem: 64-1 error codes
   Solution: On the motherboard, the yellow 4-pin connector was not connected; a bad MPU board was found, the red/blue connector was disconnected, and a RAM clear was needed.
5. **ALL THEMES**
   Problem: Many reel tilts, bell ringing, and meters incrementing during a reel spin
   Solution: It was found many of the CPU boards that were provided in the kit were missing the 27pf IGT upgrade.
   Repair: On all 16MHz CPU boards with the part number 755-115-00, 755-115-01, and 755-115-02, you will need to solder the 27pf CAP to U21 pin #1 and the other end to the ground end of C20.
6. **ALL THEMES:**
   Problem: Constant 80 codes after the spin button was pushed or the handle was pulled.
   Solution: The game frame unit needed to be reseated.

OVERVIEW

Many of us technicians have done your classic theme and denomination conversions. This was my first experience of a conversion of this scope and duration. Each game required one to two hours including the clear and set procedures. The more conversions you did the less time it took to complete. This was a fun conversion to perform along with all the troubleshooting that took place after all the wiring was done and all the parts assembled into the games. The four themes that we currently are using are doing well for 18 games and two different denominations (quarters and half dollars). All the information for the EPROMS and including the PAR sheets could be found on IGT's web site. I would of like to have had pictures taken for these conversions but due to our Gaming Commissions policies and procedures, they do not allow pictures to be taken on the gaming floor.

-Kevin Noble
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End of Life Issue

Last Call for Kortek KT1703V Series and KT2003N Series Monitors

Kortek Corporation has announced that they will soon not be able to provide key parts for two long discontinued monitor models that are still widely used in the Traditional and Indian gaming markets. These two models are the KT1703V series and KT2003N series monitors. Kortek has announced that they will soon deplete their stock of CRTs and PCB Board Sets for these two monitors. They are offering a final buy opportunity for these parts in an effort to extend the life of games using them.

The KT1703V series monitors were used primarily in the IGT 17" Super Slant games under a variety of titles. These monitors were manufactured by Kortek, but assembled and distributed by TelcoVision, a former supplier of Kortek private label monitors. These monitors can be identified by the TelcoVision label, the KT1703V... part number, and the 17" Phillips M41EEM... CRT in them. The IGT part number on this monitor is: 69918900 or 69921000. Many properties in Vegas and Atlantic City still have games with these monitors.

The KT2003N series monitors are found exclusively in games by Sierra Design Group or SDG. These games are 20" Upright touchscreen and non-touchscreen video reel games under a variety of titles. These were manufactured and distributed by Kortek. They can be identified by the Kortek label, the KT2003N part number and the 20" Chungwa M48AHF... CRT in them. The SDG part number for this monitor is 69921201 or Y11669. Many Indian gaming properties in Washington and California have games with these monitors, especially Washington.

Kortek Corp and its authorized service center, Casinotech, strongly suggest that all properties consider if they have these games on their floor. If so, consider what their parts needs will be to support these monitors for the future. These games can only use these specific monitors, so to extend the life of these monitors, casinos should obtain needed CRTs and PCB Board Sets immediately. This is clearly much less expensive than replacing the whole game.

In anticipation of this discontinuation, Casinotech, Kortek's authorized service center has purchased all remaining stock of KT1703V and KT2003N CRTs and PCB Board sets from Kortek. Any properties needing these parts should contact Casinotech while they have stock. Any inquiries related to this issue can be directed toward Casinotech. Casinotech is located in Las Vegas and can be reached at 702-736-8472, or at CASINOTECH@LVCM.COM

Note: IGT is registered to International Game Technology located in Reno, NV. Sierra Design Group and SDG is registered to Sierra Design Group and located in Reno, NV. TelcoVision is registered to Telco Intercontinental and located in Houston, TX. Source of information was Casinotech and verified by Kortek.

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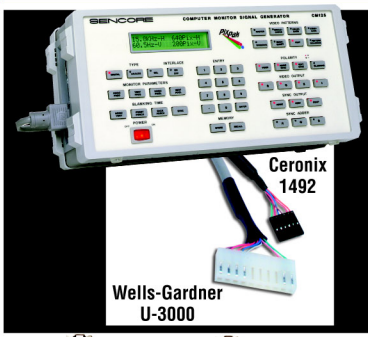

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Who's your PAL?

By Herschel Peeler

They are called Programmable Logic Arrays, or Programmable Array Logic, by different manufacturers, and they are the hardest thing to troubleshoot through. Everybody uses them and they have a high failure rate. What goes on inside these puppies and what can we do to troubleshoot something we do not know what looks like on the inside?

Standard ICs we can look up in a data book and learn about. Once we understand what the chip does, we can troubleshoot through it in a circuit. But the contents of a PAL are never the same. We can't go out and buy them over the counter. The PAL 16V8-25 we can buy from a distributor is unprogrammed, and can not be put into a circuit and expected to do anything functional.

Programmable Logic is exactly that, programmable. It has 16 Input lines, 8 of which may also be used as outputs. What the circuit inside is like is electrically alterable by a Programming-like process. Inside is an array of gates, like an encoder and a decoder connected together. The connections between the two are alterable. Let's take a typical example of how one is used and what it accomplishes.

Address Decoding Application

A typical application is address decoding for a microprocessor. Most of the logic boards in the gaming industry of the last ten years have used at least one in this type of application. In older microprocessor based systems, a circuit something like the one shown in figure 1 was used to decode the address lines from the microprocessor to select various memory or I/O devices. In our very simple example we only used two ICs. In other applications it would likely include four or more ICs, perhaps another decoder, and a couple of gates for various functions.

In the example in figure 1, we need to decode the address lines to select five memory devices at different address ranges.

This same circuit may be programmed into a PAL and compressed to only one IC, as simple as the one shown in figure 2.

More realistically, we compress dozens of gates down to only one IC saving board space. This also makes the design of the IC more flexible. When we change the size or configuration of our memory chip(s), we do not have to redo the design of the board in this area. This also makes this component of the board proprietary to the manufacturer. This, I think, is more of a secondary benefit.

Programmable logic may also take on a larger form, called Standard Cell Array, where entire circuits of hundreds of chips may be compressed into one chip. We see many of these on our boards today.

Troubleshooting and PALs

As long as you know what the circuit is supposed to accomplish you can troubleshoot problems down to, or through, PALs. These guys have a fairly high failure rate. The components inside are

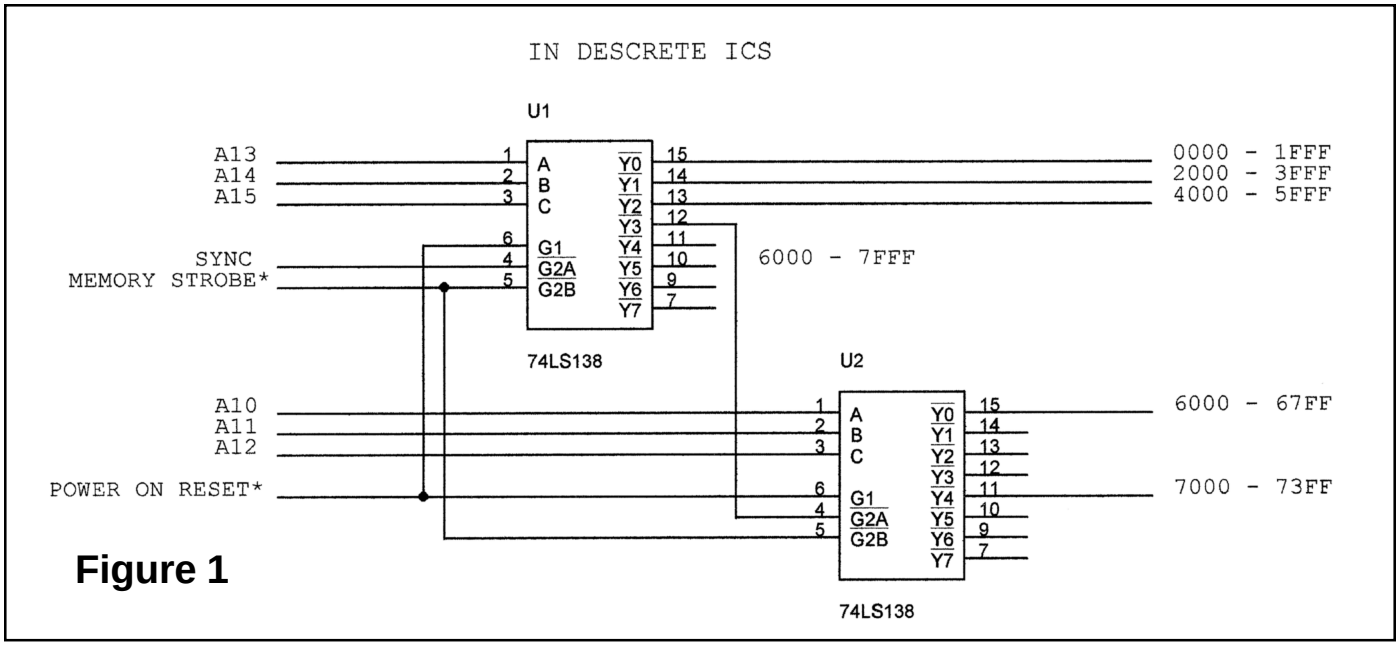

Figure 1

built of sub-micron technology. Meaning the width of what would be a wire is less than one micron wide. Address Decoder applications, as mentioned above, are circuits that have a high degree of signal activity. That results in more heat build up in that circuit, and that means a higher chance of failure.

Troubleshooting boards is a matter of matching symptoms to what circuits on the board do that function. If only one symptom is present (one hard meter keeps running) the problem can be narrowed down to only the circuit that drives that output. If the problem affects other outputs (player panel lamps doing strange things), we look for what things these two circuits have in common. If everything seems to be doing weird stuff, look for a power problem. Do the malfunctioning circuits have a common power supply?

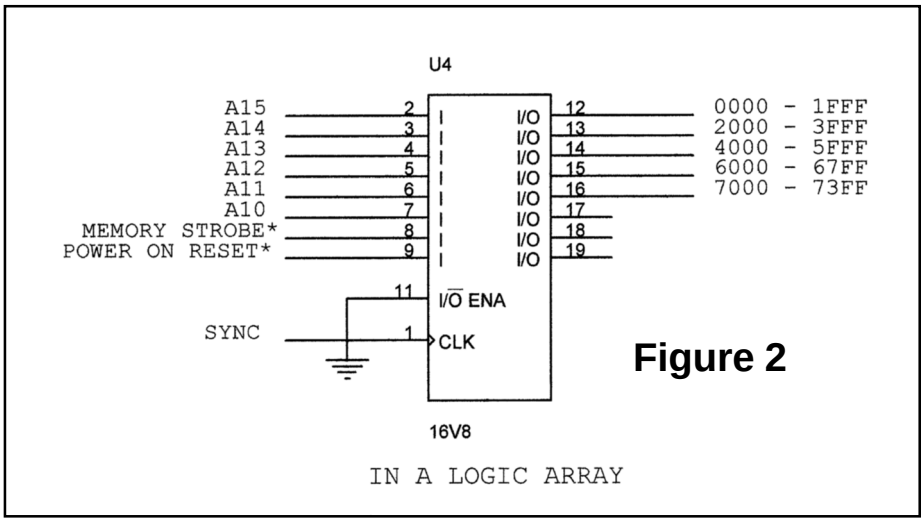

Figure 2

In the case of one tech who wrote into the forum with two symptoms related to one board, the main thing they had in common was a PAL on the I/O board. We haven't heard the outcome yet, but from having worked on a lot of boards, I'd bet my lunch money on it.

Forums mentioned:
http://forums.delphiforums.com/slottechs
http://forums.delphiforums.com/benchtech

If you have internet access, these are worth keeping up on. Quite a few good techs answer and post questions on the forum. If you are finding a problem that's a head scratcher, or found a problem, tool, or what ever you would like to share, we would all be glad to hear from you.

- Herschel Peeler
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Inside IGT's New Advanced Video Platform

By Ken Locke

In previous articles I have been tempting you with the notion that there are dazzling new gaming technologies that are going to appear on your horizon. You were told that the slot machine technologies that you have come to know and love are about to be stood on their collective ears. For the first time, you are about to get an exclusive look at the future. Here comes AVP.

IGT's new Advanced Video Platform (AVP) is a completely new format in game design. Four years of extensive engineering have created a gaming machine like nothing you've ever seen. Using technology similar to that found in today's personal computers, the AVP incorporates significant changes to the logic components and game software. Now that all sounds very ominous but the truth is slot technicians and regulatory agencies alike are going to be scrambling a bit to get used to the new design. They will also have to adjust to some new procedures.

The first iteration of AVP will come exclusively in the form of mega-jackpot, wide area progressive machines. Look for themes like Lifestyles of the Rich and Famous, Monty Python and a revamped version of Wheel of Fortune. These are all scheduled to roll out in 2003. California Indian properties will mostly have the first installations of the new machines.

So, what's so different about AVP? Where to begin? Let's start in the center and work our way out. The heart of the AVP system is what IGT is calling the "brain box." They have modified off-the-shelf PC components for use in the logic section. But even the logic areas will have their differences from game to game: AVP I and AVP II.

AVP I will use an AMD processor, while AVP II employs the Pentium III. Both versions however require their own custom hard drive and DVD ROM drive to enable the program software. AVP WOF games will use the Pentium III class board. All of the game software released after Lifestyles will require the AVP II Brain Box. The good news is that any AVP I platform can easily be upgraded to the Pentium.

There is also a whole new language of components and software you'll need to be familiar with. The AVP I Secure Boot program will be stored on two separate one-time-programmable (OTP) PROMs, labeled conveniently enough "BOOT 1" and "BOOT 2." BOOT 1 contains BIOS information specific to the manufacturer of the main processor board. BOOT 2 Contains the QNX operating system kernel, random number generator and IGT authentication code. They are installed in sockets on the main processor board.

QNX is a real-time operating system (RTOS) that is very stable, fast and most importantly, secure. This package of software contains the basic operating system for the AVP product line. BOOT 2 will also contain some QNX files that are required to allow the machine to boot up. The QNX package is copied directly to the 40 GB hard drive (also known as the Mass Storage Device) from an installation disk.

The AVP Package contains IGT's operating system that

works on top of QNX. These are also downloaded from the installation disk to the hard drive. Think of these files much like the "G" or "SG" programs used in the 80960 platforms.

The Configuration Package works in conjunction with the AVP package. This controls certain game functions, denominations and operator configurable game parameters. Again, this is all copied into the Mass Storage Device from the installation disk.

The Game Package contains the program information specific to the game theme, including paytables, game sounds and graphics. This could be compared to the Base PROMs or SS chips of older platforms.

Now, some of you are thinking, "Hey, I saw the movie Hackers. What about security?" Well, aside from proving that Angelina Jolie had no acting ability prior to 1996, it does raise a good point. How do you keep the bad guys from getting into your slot system?

The AVP has several layers of security, both hardware and software. First it utilizes a Digital Signature Algorithm for internal program verification. Each time the machine boots up, the contents of the hard drive are authenticated against the DSA codes contained within the Secure Boot program. If at any point the DSA authentication fails, the game will terminate the boot-up process.

A serialized USB card, known as the E-Key, will be required to load any game software, change privileged options or perform advanced diagnostics functions such as clearing memory. The socket for the E-Key is hidden behind the Brain Box door and an

optional E-Key cover can be installed with a serialized seal. The Secure Boot program will verify the E-Key upon insertion.

On the hardware side of things, the Brain Box enclosure can be secured just like 80960 products and can be configured with one or two locks. Gaming Control can further use chassis seals or evidence tape to regulate access.

Both the MSD and DVD drives can only be accessed if the Brain Box's main door is open. If a disc is loaded into the DVD and does not pass muster with the Secure Boot program, its contents will not be downloaded to the hard drive.

It's even harder to tamper with the Mass Storage Device. It is, by default, Write Protected. The only way that data can be written onto the drive is by using the correct E-Key and a Write Enable Jumper is installed. The AVP processor will suspend operation if the write protection is disabled at any point during normal game operation.

A little more on these E-Keys. There are three types: Installation, Privileged Options and Advanced Diagnostics. The installation key is required to load any program software to the hard drive. The Privileged Option key allows you to access and change certain game options. Finally, the Advance Diagnostics key is used in conjunction with a diagnostic disk. This is needed for things like clearing memory. Since the very first AVP releases will be wide-area progressives, only IGT and SODAK personnel will have access to them. Chances are, if you suck up to them, they may let you watch the process.

Artist's impression of the USB security key

If you happen to be a gaming regulatory agent, I can already hear you saying, "How can I be sure what you are saying is true, Herr IGT guy?" (insert East German accent here). There are three methods used by AVP products that allow you to verify program information. External verification comes in the form of a serial (DB9) connector that allows for a direct interface with a laptop or PC. The serial interface is secured behind the Brain Box. A verification utility is available from IGT that allows you to verify the signature using one of three methods: 32-bit CRC, MD5 Algorithm or SHA-1.

Internally, the game software includes a CRC verification utility, which can calculate a program signature. Lastly, a third-party verification has been produced by GLI in the form of verification CD. This compact disc is inserted into the DVD drive and will calculate and display the 32-bit CRC for each software component.

It is important to point out that the Secure Boot program information is not downloaded to the MSD. You will have to verify this puppy using a Kobetron, Dataman or Bit-By-Bit comparison device. Got one? Well before you get too excited, the AVP II processor will use a 42-pin socket for one of the boot proms and that means a Kobetron 3000 with a 42-pin adapter (insert manly grunt here).

Had enough? No? Okay, let's talk ... communication that is. The AVP product supports SAS 5.x and Bally Simple Serial protocols to communicate with just about every Player Tracking System you can think of. The same statistical and account data that casinos count on will still be there. On top of that, the hard meters have been expanded to support seven digits.

As with all Mega-Jackpot machines, the connections to your PTS must be fiber optic and IGT was kind enough to provide specs to all of the PTS manufacturers out there with imbedded player tracking components. Of course that also means that they will have to start making all new nifty brackets and deco plates.

The communication board from the old i960 is still the same and this should allow

you to use the harnesses you've been using with your existing IGT machines. You can also get an optional UPTI kit for IGT, Bally, and Acres systems which supports fiber optic drop door monitoring.

The Nuts and Bolts

A shorter slot stand is required due to the height of the player panel. Specifications will be made available if you want fabricate your own. A standard size slot chair will work beautifully as long as your slot stand is the right size.

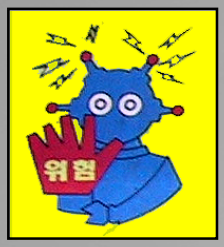
Since the initial release of AVP will be limited to MJP, there shouldn't be much need to stock any new and unique parts for the new AVP product. Internal peripherals such as ticket printers, BVs, hoppers and the like, are happily compatible with existing 80960 lines. Parts unique to the AVP, such as the monitor, USB bezel, power supplies and logic will be the responsibility of IGT.

One thing that may be significant is the power recommendations accompanying this new machine. IGT recommends no more than three AVP machines per 20-amp circuit and perhaps only 2 machines on the new WOF's with their bonus wheel devices. Many properties are running as many five slot machines per ground under their current floor configurations. Something to consider if AVPs arrive at your house. Well that's just about the whole shootin' match. Oh wait! I have forgotten the best part, the one quantum technological advancement that places AVP as the new standard in gaming... cup holders.

- Ken Locke -
Ken.locke@igt.com

Slot Tech Magazine Visits Kortek Monitor Factory in Korea

Call me a nerd but one of my favorite things to do in the whole world is visit factories. I've taken tours of many different types of factories — game manufacturers, power supply manufacturers, test equipment manufacturers – but my keenest interest is in touring monitor factories. I've been to the Wells-Gardner plant in Illinois, a Pentranic factory in I Image plant in Mexico, the Sony plan California (where the manufacture t selves) and a couple of factories in Italy fascinating how the whole thing comes I invite you to join me now as Slot Tech the Kortek monitor factory in Seoul, begins, bottom-left.

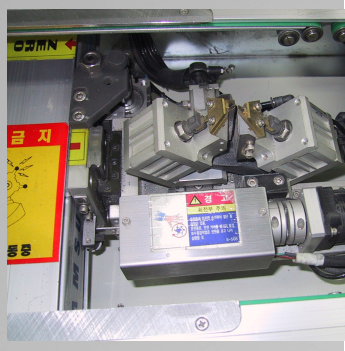


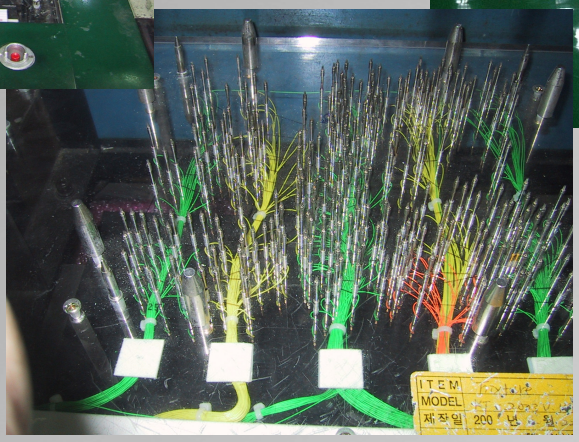
Who the heck is this guy? robot/alien/whatever all ov sembly line. It's a warning some kind. I have no ide means but it's really kind

Meet Moon Kee "call me Mike" Hong, Vice President of Research and Development, Production and Quality. Mr. Hong and I had met previously at the Global Gaming Expo. He took me on a tour of the assembly line. Here we see him reaching into one of the many parts bins along the assembly line. Talk about a technician's dream come true . . . Imagine working in a repair shop where your had easy access to every single component in a monitor. You could fix anything! *Follow couinter-clockwise to take the tour!*

This is called the "cut & clinch" machine. Cu ciency and quality of any manual assembly me & clinch method over trimming the leads by ha ponent spillage or pop-up during wave solderin post-solder lead trimming. All of this means a sembly of the PCB.

The cut & clinch machine operator views the bo lates the cutting & clinching bits into place. The proper length, and bend them in (that's the "cl during the wave soldering process that follows





Indiana, a Sharp
nt in San Diego,
he CRTs them-
as well. It's really
together and so
Magazine visits
Korea.The tour

I saw this
ver the as-
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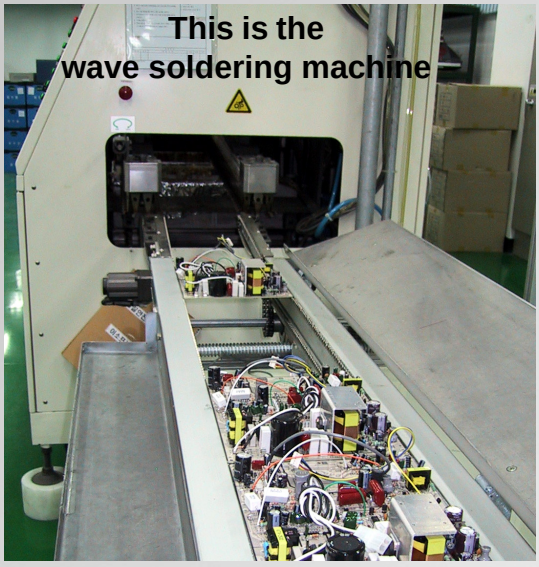
ea what it
a cool.

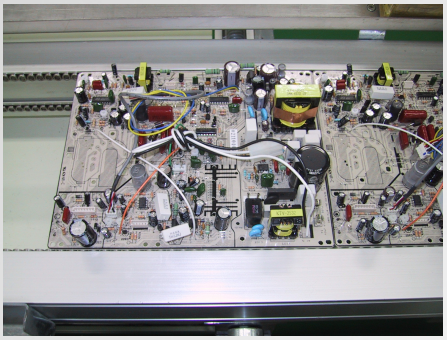
This is known as a "bed of nails" tester. Its function is pretty obvious. The completed PCB is placed on top of the bed of probes, which make contact with the bottom of the PCB. Wires lead from the nails to a non-destructive exorciser that tests functionality and looks for shorts and opens without applying full power to the monitor.

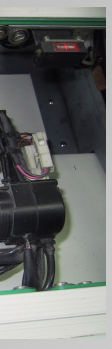


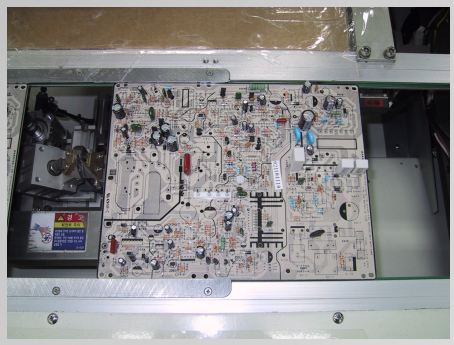
t & clinch assembly provides the highest effi-
ethod. There are many benefits to using the cut
and, including improved solderability, no com-
ng, simple lead forming, easier insertion and no
better product with less fall-out and faster as-

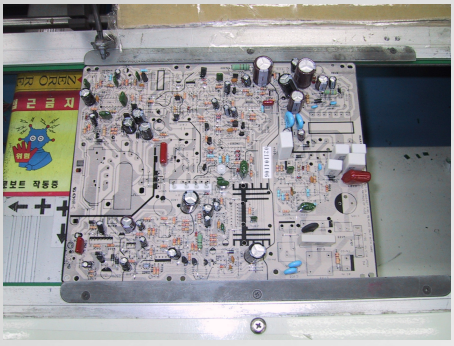
ttom of the PCB on a small screen and manipu-
e bits grab the component leads, cut them to the
inch part"} so they remain in place on the PCB
s.

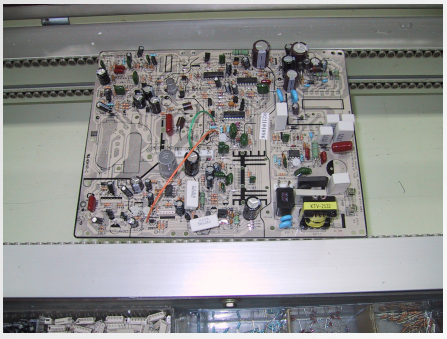
Here you see the progression of the PCB, as more and more components are added on its way to the wave-soldering machine.

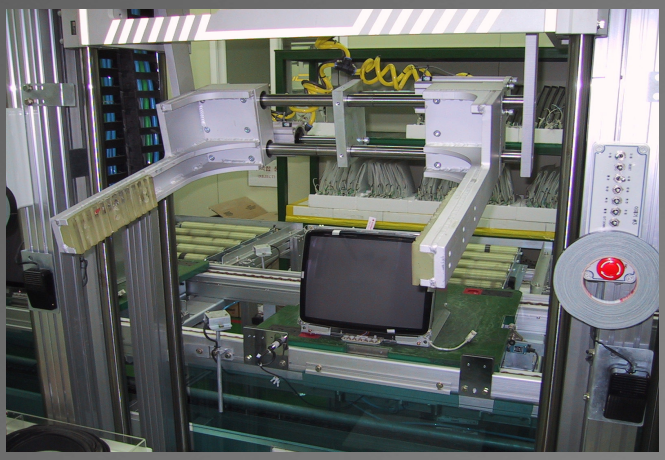








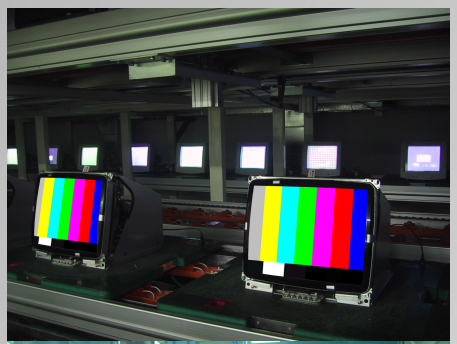


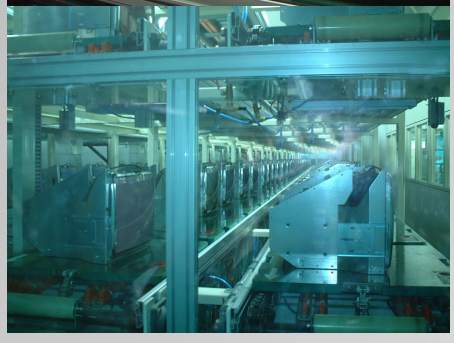


This is the touch screen integration room where the sensor is attached to the face of the CRT. This is a "clean room" so that dust or other contaminants do not become trapped in the gap between the touchscreen sensor and the face of the CRT. A machine actually grabs the completed monitor and holds it in place while the sensor is attached. This is one of many machines that perform the task of moving CRTs, and completed monitors (boxed and unboxed) around the factory. This is to prevent worker injury. Kortek's commitment to their workers even extends to an on-site dormitory where single workers (men only) are housed. See below.

This is another handling machine that picks up the monitors and puts them into the shipping containers.

These are the "Drop Test" and "Shaker" machines. I didn't get to see these two in action but they are used to test the packaging of the monitors. I'm not sure why you need a special machine for the drop test but look at the size of the motor on that shaker table! That must shake the hell out of the monitor.



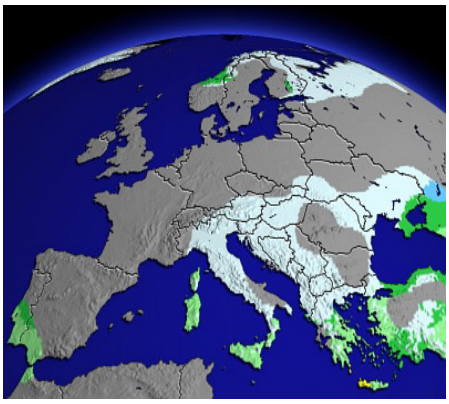


From left to right: Edward Kim, Vice-President of Sales and Marketing, Moon Kee Hong, Vice-President of Research and Development, Production and Quality, Young Lin Yoo, Vice-President of Finance, Planning and Personnel, Randy Fromm, Publisher, Slot Tech Magazine and Scott Chung, Manager of Sales and Marketing.

This is the burn-in room (left) where each monitor spends 12 hours, subjected to high temperatures. The actually temperature varies as the monitors are automatically moved around by conveyers. The monitors are energized as they make the trip through. Generally speaking, if a monitor is going to fail, it will happen either in the first few hours of operation or after a few years. The burn-in room weeds out the bad ones before they leave the factory. Pictured above is another burn-in rack. This time, it's an extended burn-in at room temperature where the line voltage is varied as the monitors burn. Here we see a rack of monitors destined for Atronic.

International View

By Martin Dempsey



New Doubly Secure Lock From Camlock

Latest innovative development from Eastbourne-based security specialists Camlock Systems is the 'Supervisor', a high quality special purpose camlock designed to work only when holders of two different keys are in attendance. Ideally suited for use in cash handling or restricted access situations where two key holders are required to be present to prevent dishonesty, the Supervisor camlock can be retrofitted to most popular gaming machines and associated equipment. Further information from Stephen Farnsworth, Camlock Systems, Eastbourne. Tel: + 44 (0)1323410996. Email: sales@camlock.com

TCS Goes On Tour

Unveiling its most ambitious project to date TCS has announced its long-awaited European tour dates. Thought to be the first venture of its kind within the gaming industry, the TCS European sales team will be on the road for three months taking the company's key products in a mobile showroom to all major customers across Europe. The tour will kick off in the UK at the ICE show in January before departing for the continent. The mobile showroom will visit 13 countries in all, including France, Spain, Portugal, Italy, Germany, Austria, Switzerland and Slovenia.

Regular Tour updates will be available on the dedicated web page at http://www.tcsgroup.com/tour

Email :Debbie.Dixon@TCSGroup.com

Red's Website Challenge!

Red Gaming has received an astonishing 40,000 different visitors to its website since its launch in May 2002, from over 50 countries around the world including Nicaragua, Brazil, Iceland, Hong Kong and the US! Visitors to the site are invited to enter a devilishly difficult on-line competition. Players collect keys as they complete different sections of the competition, including a 3D maze, a skill stop trail, a 3D ball bouncing puzzle, helping the Devil catch a fish and a hi/lo sequence predictor.

For further information please contact Clare McMillan / Sam Drakeford @ MediaWorks.
Tel + 44 (0)113 234 5600.
Fax + 44 (0)113 234 5601.
Email: pr@mediaworksccl.com
Website http://www.redgaming.co.uk

Extreme Sprints Ahead With "Note Runner"

On the back of almost two months of outstanding test results, Extreme Gaming has launched its latest UK AWP, Note Runner. Having secured product approvals from the majority of major retailers,

advanced orders for the game will keep the Maygay Group's Wolverhampton factory busy into the New Year. The distinctive cartoon-themed game combines a traditional 'wrap-around' board game with a 'No Lose' hi/lo disc feature which itself concludes with a 'Note Climb' across the top glass. For further information, please contact Paul Howarth, Commercial Manager, Extreme Gaming. Tel: + 44 (0)161 678 6344. E-mail: :paul@extremegaming.co.uk

wh Münzprüfer New Product With 2-Way / 3-Way Sorter

wh Münzprüfer now offers their 3.5" electronic coin validator with coin sorting. This component is called SRT 800 and offers the EMP 800 with 2 or 3-way sorter for sorting to hopper and cash box. It is available as frontplate version (with standard, mini or even metal frontplate) or for chassis mounting. The sorter is easy to mount and the sorting paths can be either driven by the EMP 800 (fixed sorting paths) or by the machine controller (variable sorting paths). Two versions are available: SRT 800.2X (for two-way sorting) and SRT 800.3X (for three-way sorting). For further information please contact Andrea Weiblen-Barnick, wh Münzprüfer Dietmar Trenner GmbH. Tel.: + 49 30 845 723 - 0. Fax: +49 30 845 723 - 23. Email :sales@whberlin.de
Website http://www.whberlin.de

EuroBaz At London's ICE Show

EuroBaz International participated at London's International Casino Exhibition from 21st - 23rd January for the first time, in booth 5299 in the special online casino area.

Based in the UK, EuroBaz is a business partner and European distributor for the gaming and leisure world and represents a small number of hi-tech and futurist companies with an eye for innovation and creative product lines.

For further information contact EuroBaz International Ltd., Unit 8 Kingspark Business Centre, 152-178 Kingston Road, New Malden, Surrey. KT3 3ST. United Kingdom. Tel: +44 (0) 2089 422 777. Fax: +44 (0) 2089 423 756. Email: sales@eurobaz.co.uk Ask for Barry Thompson, Steve Cook, Joan Gimenez, or visit their website http://www.eurobaz.com

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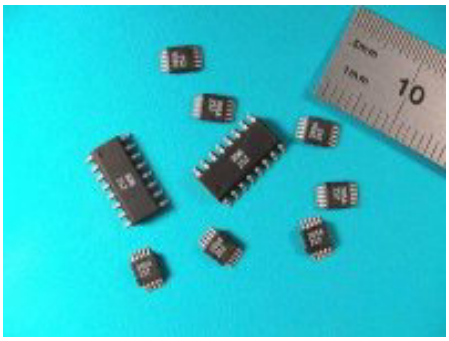


DUREL Introduces Powerful New Electroluminescent Lamp Drivers

Durel Corporation, an affiliate of 3M and Rogers Corporation, expands its family of electroluminescent (EL) lamp driver products with the introduction of its new D305A and D306A high-power IC drivers. With the D305A EL driver as part of a high-brightness EL (HBEL) lamp system, designers can achieve up to four times the luminance of traditional EL lamp systems for PDAs and other wireless electronic devices. The D305A is capable of driving EL lamps as large as 100 cm2 with very high voltage AC output from a 2.5 to 7.0 Vdc supply voltage. It is equipped with many control functions, including wave-shaping(tm) programmability for minimizing audible noise, and other features that allow for component cost savings, precision control of frequencies, and stability of lamp color over wide-temperature extremes. The D305A is available in a space-saving MSOP-10 package in tape and reel.

The D306A is a powerful device that can convert a wide input voltage range from 2.0Vdc to 16.0 Vdc to an output voltage of 400V peak-to-peak. It is ideal for lithium-ion and alkaline battery powered applications. Intended for signage, instrumentation displays and other large backlighting uses, the D306A can drive EL lamps as large as 180 cm2. This Durel IC is also equipped with proprietary wave-shaping(tm) programmability for reducing audible noise. Dual on-chip oscillators allow for independent selection of inductor switching and lamp output frequency optimization through the choice of external capacitor values or with separate external clock signals. The D306A is available in a narrow-body surface-mount SOIC-16 package with heat slug and requires a minimal number of external components.

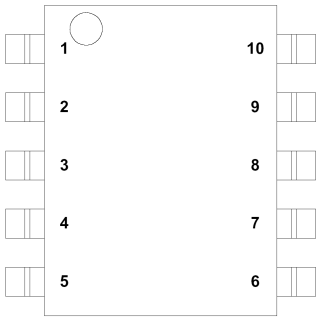
Samples of D305A and D306A are currently available from stock. Durel also offers D305 and D306 EL Driver Designer's Kits for a nominal fee to aid designers in configuring an optimized circuit for their application. Each kit contains a Durel prototype EL lamp, sample D305A or D306A units, pre-soldered Kit board and mini-board, and several values of surface mount external components that can be interchanged in the course of evaluations. Datasheets, reference circuit designs, and additional technical information on the Durel D305A and D306A EL drivers can be found on the Durel Web site at www.durel.com.

Design Considerations

External clock signals may be used to control the D305A oscillator frequencies instead of adding external passive components. When clocking signals provide both the inductor charging (HF) and lamp output (LF) oscillator frequencies to drive the D305A, the CLF, CHF, Rf, and CRf components are no longer required. A sample configuration demonstrating this cost-saving option is shown in figure 2.

In this configuration, the lamp frequency is controlled by the signal applied to the CLF pin. An internal divider network in the IC divides the frequency of the LF input signal by two. Thus, to get a 400 Hz AC output waveform to drive the EL lamp, an 800 Hz square-wave input signal should be connected to the CLF pin. Input clocking frequencies may range from 400 Hz to

Physical Data - Figure 1



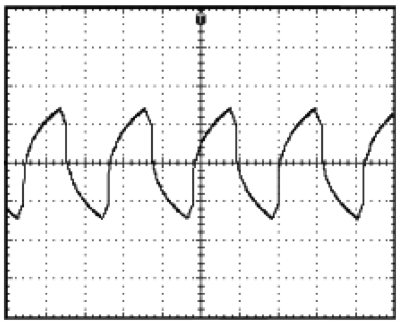
PIN #	NAME	FUNCTION
1	Va	AC voltage output to EL lamp
2	Cs	High voltage storage capacitor input
3	Vb	AC voltage output to EL lamp
4	E	System enable; Wave-shaping resistor control
5	Vcc	Logic drive voltage
6	CHF	Capacitor input to high frequency oscillator
7	CLF	Capacitor input to low frequency oscillator
8	Rf	Resistor input for frequency control
9	GND	Power ground
10	L	Inductor input

Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Unit	Comments
Supply Voltage					
Operating Range	Vbat	2.0	7.0	V	E = Vcc
Withstand Range		-0.5	16		E = GND
Logic Drive Voltage					
Operating Range	Vcc	2	5	V	E = Vcc
Withstand Range		-0.5	6		E = GND
Enable Voltage	E	-0.5	Vcc + 0.5	V	
Vout	Va - Vb		410	Vpp	E = Vcc
Operating Temperature	T_a	-40	85	°C	Ambient
Operating Temperature	Tj		125	°C	Junction
Average Thermal Resistance	θjA		113	°C/W	Junction to Ambient
Storage Temperature	T_s	-55	150	°C	

Note: The above are stress ratings only. Functional operation of the device at these ratings or any other above those indicated in the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Typical Output Waveform



2000 Hz, with 15-20% positive duty cycle for optimum brightness. The amplitude of the clock signal typically ranges from 1.0V to Vcc. The high frequency oscillator that determines inductor charging frequency is controlled above by a digital AC signal into the CHF pin. The HF clock signal frequency may range from 20KHz - 35KHz, with 15-20% positive duty cycle for optimum lamp intensity. The amplitude of the clock signal typically ranges from 1.0V to Vcc.

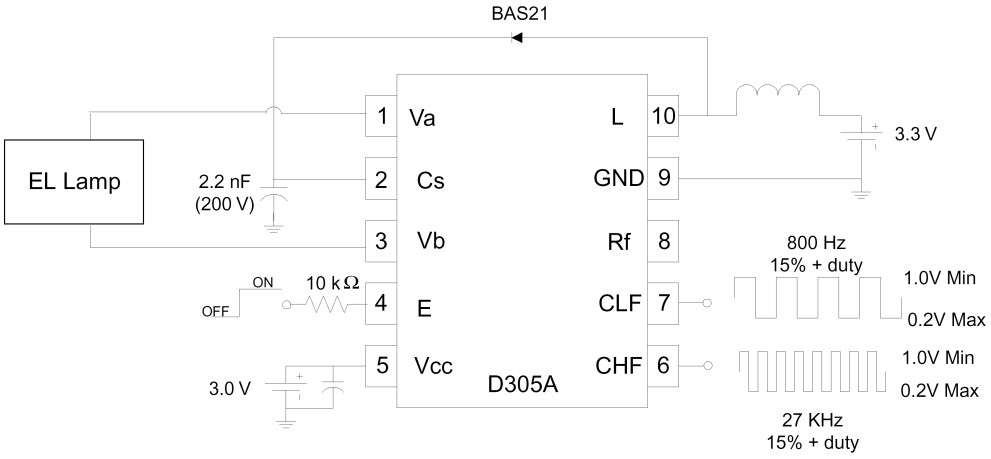
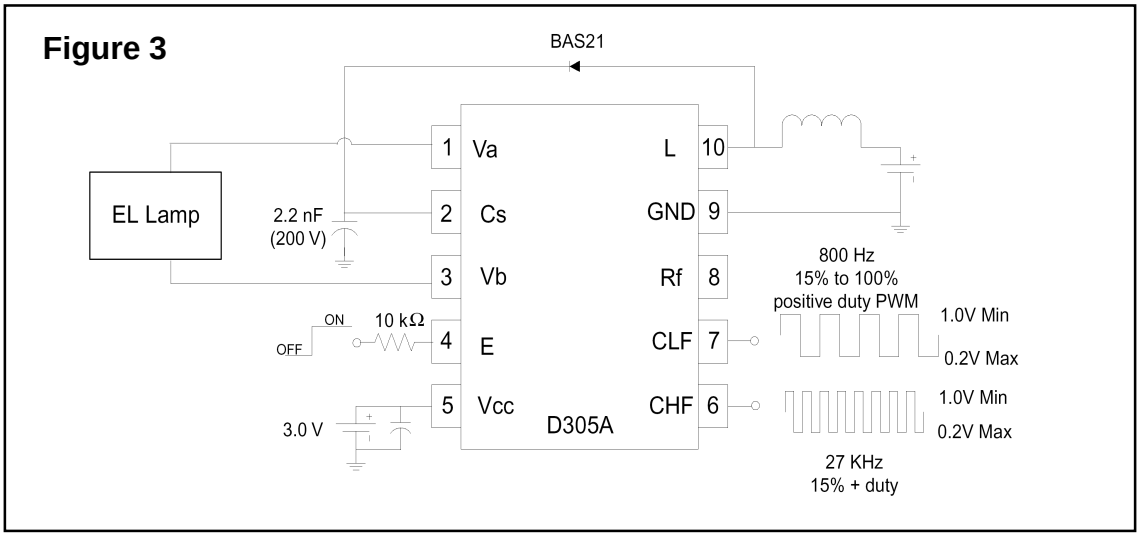


Figure 2. - In this configuration, the lamp frequency is controlled by the signal applied to the CLF pin.

Controlling EL Brightness through Clock Pulse Width Modulation

Pulse width modulation of the external LF input signal may be used to regulate the brightness of the EL lamp (SEE FIGURE 3). Figures 4, 5, and 6 below demonstrate examples of the D305A output waveform with pulse width modulation of the LF input signal. As the positive duty cycle of the LF input signal is increased from 15% to 100%, the charging period of the output waveform decreases, and the peak voltage of the output waveform also decreases towards zero output. Therefore, incremental dimming occurs as a result of the wave-shaping changes. This scheme may also be used inversely to regulate lamp brightness over the life of the battery or to compensate for lamp aging. Operation at duty cycles lower than 10% is not recommended. Clocking frequency can range from 400 Hz to 2000 Hz. The maximum amplitude of the clock signal may range from 1.0V to Vcc. Luminance (fL) Current Draw (mA)

Figure 3



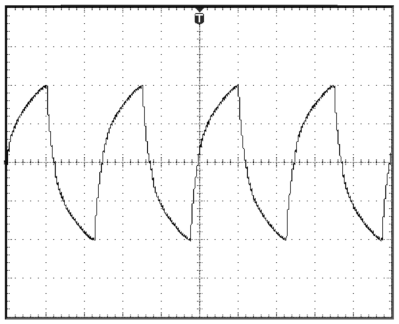


Figure 4: LF Input Duty Cycle = +15%

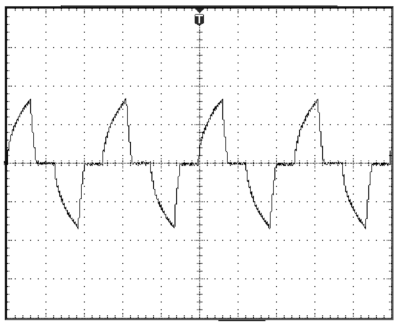


Figure 5: LF Input Duty Cycle = +50%

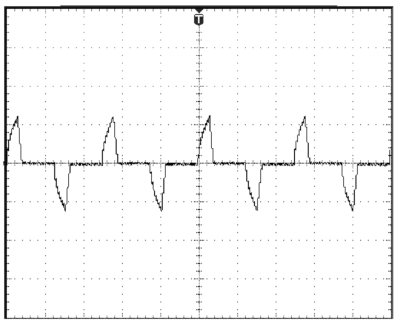
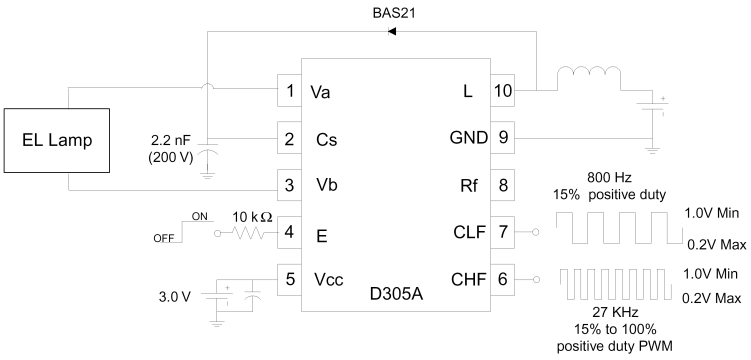


Figure 6: LF Input Duty Cycle = +75%

Figure 7 - Controlling EL Brightness through Clock Pulse Width Modulation



Controlling EL Brightness through Clock Pulse Width Modulation

Pulse width modulation of the external HF input signal also may be used to regulate the brightness of the EL lamp (see figure 7). As the positive duty cycle of the LF input signal is increased from 15% to 100%, the peak voltage of the output waveform decrease incrementally to zero output as the inductor charging period is affected by the HF duty cycle. Lamp dimming is thus achieved with pulse width modulation of the HF input signal to the D305A. This scheme may also be used inversely to regulate lamp brightness over the life of the battery or to compensate for lamp aging. Figure 8 shows a typical dimming curve with this technique. The recommended HF duty cycle range is from 10% to 95%. Clocking frequency can range from 20 KHz to 35 KHz. The maximum amplitude of the clock signal may range from 1.0V to Vcc. Luminance (fL)

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- Slot Tech Magazine

Editor's Note: This information from your friends at Coin Mechanisms, Inc. was presented at TechFest 4. At that time, we were unable to provide everyone with copies and so, here it is. Enjoy.

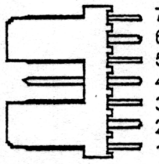
INTELLIGENT COMPARITOR

SYSTEM PLUS WIRING DIAGRAM

LOCATE CONTROL PCB PART NUMBER BELOW AND REFER TO ADJACENT CUSTOMER INTERFACE DIAGRAM

PCB PART NO. CUSTOMER INTERFACE

09270414
09270430
09270439
09270451



7 PIN MOLEX 12VDC IC-16 SIGMA OPTIC

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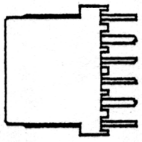
09270438
09270464



6 PIN MOLEX 13VDC IC-16 IGT 960 SERIES

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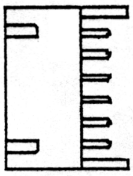
09270435



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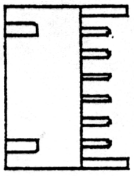
09270437



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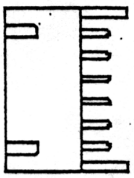
09270419
09270443
09270444



6 PIN JST 24VAC/DC, IC-40 NO INHIBIT

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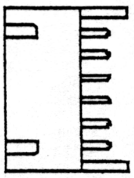
09270423
09270447
09270448



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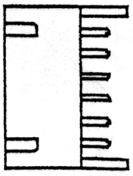
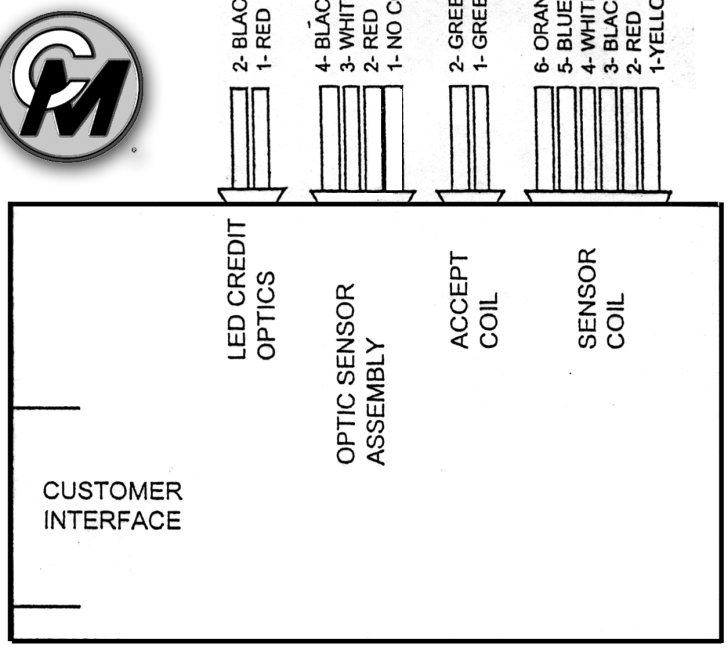
09270417
09270441
09270442



6 PIN JST 12VDC, IC-40 NO INHIBIT



PCB PART NO. CUSTOMER INTERFACE

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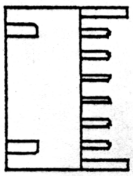

6 PIN JST 12VDC, IC-40 INHIBIT HI

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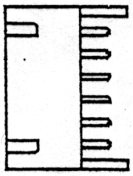

6 PIN JST 24VAC/DC, IC-16 NO INHIBIT

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09270449
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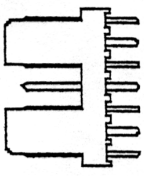
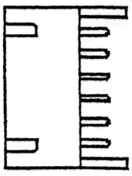
09270477



7 PIN MOLEX 12VDC, IC-62

09270415
09270440



6 PIN JST 13VDC, IC-32/36

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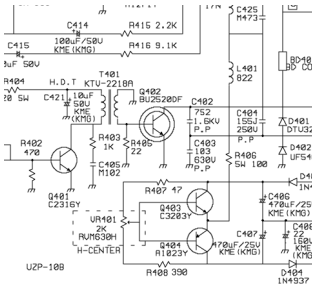
Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



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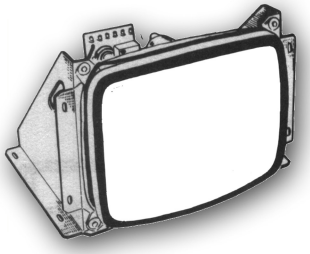

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X-Ray Protection

Would it surprise you to learn that almost every home in America has at least one X-ray machine? Your casino has hundreds or thousands of them.

Okay, maybe I'm stretching it a bit but in fact, monitors are really just an inch away from being X-ray machines. The high voltage in a monitor's CRT, combined with its electron gun, create x-rays as a by-product of their normal operation. For this reason, the glass in a CRT has a high concentration of lead. You probably know that the glass screen of a CRT is pretty darned thick. While the thickness of the glass does serve to strengthen the CRT against breakage, that is not the only reason for its thickness. The leaded glass in a CRT serves as an X-ray shield. It functions in the same way as the lead apron that your dentist uses to protect your internal organs when he takes a dental x-ray.

Almost all monitors include a circuit known as an "X-ray protector" or "high voltage shut-down." The purpose of this circuit is to shut down the EHT if it becomes excessively high in voltage. In a nutshell, it does this by killing the horizontal oscillator circuit. This prevents the monitor from emitting excessive X-rays.

The symptom of a monitor that has gone into X-ray protection mode is that you will hear the monitor fire-up momentarily but it will immediately shut down. That is to say, you will hear the crackling sound of the static electricity buildup on the CRT (if you're in a quiet shop, that is. You likely will not hear it on

An NE2 Neon lamp will verify that the monitor has entered X-ray protection mode. If you hold the lamp against the ferrite core of the flyback transformer, upon initial power-up it will blink once, showing you that the EHT has come up but shut down immediately.

the floor) but the EHT shuts down and, of course, the monitor never warms up.

An NE2 Neon lamp will verify this condition. If you hold the lamp against the ferrite core of the flyback transformer, upon initial power-up it will blink once, showing you that the EHT has come up but shut down immediately.

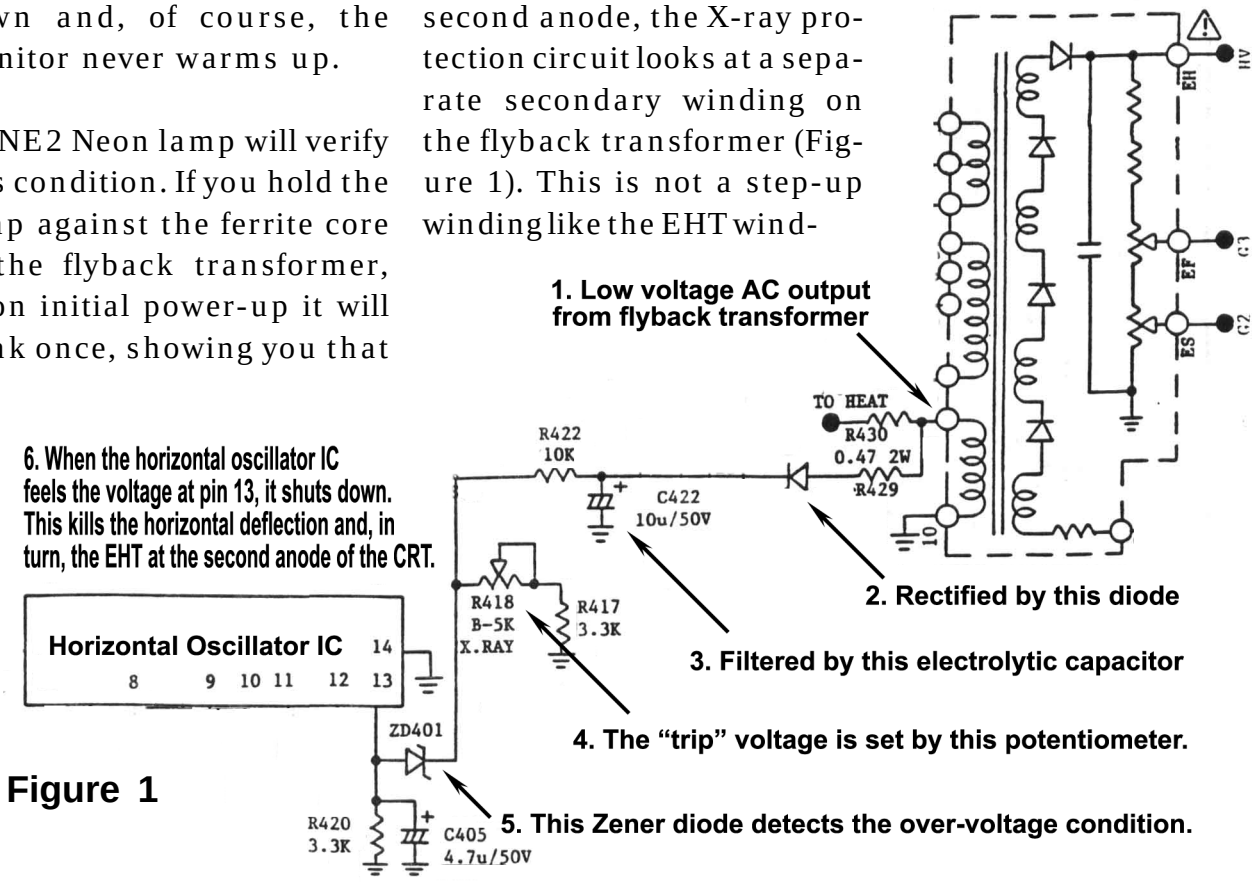


Figure 1

How it Works

In order for the X-ray protector to work, it has to know what the voltage is at the second anode of the CRT. Right away, we're in trouble here because the second anode voltage is tens of thousands of volts. In most color monitors, it's around one kilovolt for each diagonal inch of the CRT. This type of high voltage doesn't mix well with the semiconductors and other low voltage components on the monitor PCB. There has to be another way to determine the voltage at the second anode without actually touching it.

Instead of connecting to the second anode, the X-ray protection circuit looks at a separate secondary winding on the flyback transformer (Figure 1). This is not a step-up winding like the EHT winding. This is a low voltage, step-down winding. The voltage varies between monitors but typically, it's 6 to 10 volts AC. Since this winding is on the same transformer core as the EHT winding, its voltage will be directly proportional to the EHT. In other words, if the EHT voltage rises, so does the voltage at this winding. If the EHT falls, so does the low voltage AC output. By sampling the voltage at this winding, we can deduce the EHT without touching it directly.

But the output of the step-down winding needs to be tamed a bit before we measure it. At this point, it's alternating current. Pull out your back issues of Slot Tech Magazine (October 2001) if you need a refresher on transformers and why the output of a transformer is AC. Not only is it alternating current, it's AC at the horizontal frequency of 15 kHz or 31kHz or whatever frequency your monitor is using, depending on its resolution.

The fix is simple, of course. We can turn it into DC with a diode and then filter it with an electrolytic capacitor. Looks like a power supply, doesn't it? Smells like a power supply too but it's not. This DC voltage isn't going to power anything at all. This DC voltage is directly proportional to the DC voltage at the second anode. Just to plug in some typical (and easy) numbers, when the second anode is 20 kV, the DC voltage is at this point is 10 VDC. The ratio is

2000:1.

Now what? Using this proportional DC voltage, something has to detect whether or not the voltage is normal (everything's working ok - no X-ray threat detected) or if the DC voltage is too high (Warning! Danger, Will Robinson!). There is one component that suits this function perfectly: The Zener diode (Slot Tech Magazine, August 2001).

As long as everything is working perfectly, the voltage at the cathode of the Zener diode is less than the nominal Zener voltage. Let's continue to use 10 volts as an example. The Zener diode is a 1N4742 diode, rated at 12 volts. Remember, the Zener diode will not conduct until we exceed the Zener voltage so as long as the cathode voltage is 10 volts, the Zener diode will not conduct.

If the EHT rises due to some type of monitor fault (more on this later) the low-voltage will follow suit and will rise to the point where it will exceed the Zener voltage. For the sake of discussion, let's say 13 volts (representing, of course, 26 kV at the second anode - high enough to cause the emission of soft X-rays). Now the Zener diode will conduct. It will drop 12 volts and give us 1 volt at the anode.

Okay. Now we're on our way. We have created a circuit where an over-voltage condition at the second anode of the CRT gives us a 1 volt signal at the anode of the Zener diode. Now what? Well, check it out . . . The "one volt when bad" signal is connected to the horizontal oscillator IC. As you recall, this is where the horizontal deflection is born (see Slot Tech Magazine, December 2002) - the horizontal deflection that drives the flyback transformer in the high voltage unit. By killing the horizontal oscillator, you kill the EHT, hence you kill the X-ray hazard. Sweet.

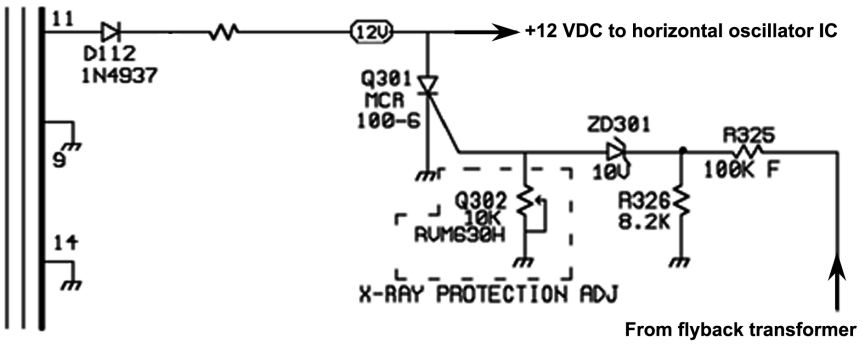
In another X-ray protection scheme, the signal from the anode of the Zener diode is used to gate an SCR (see Slot Tech Magazine, May 2001) which, in turn, drags down the +12 VDC power supply buss to ground. Since the horizontal IC needs this +12 VDC to operate, the oscillator is killed. The SCR latches the protection condition until the fault is rectified and power is reapplied. This is how Kortek does it in their KT-1703NA.

What is the Cause?

That's all well and good. Protection is a good thing. But what can cause the monitor's X-ray protector to kick in? What type of failure can cause the monitor's CRT to become an X-ray generator? Generally speaking, there are just two things that activate the X-ray protector, one of which is much more common than the other.

The most common cause of this problem is a power supply voltage that is unacceptably high. When the B+ power supply voltage rises, naturally all of the voltages in the monitor rise as well including the EHT at the second anode of the CRT. This is what causes excessive X-radiation.

In most SMPS designs, there is a reference voltage that is derived from a "sense" winding on the power transformer. It usually consists of a simple



In another X-ray protection scheme, the signal from the anode of the Zener diode is used to gate an SCR which, in turn, drags down the +12 VDC power supply buss to ground.

circuit with a single diode and a small filter capacitor. The capacitor is often in the range of one to one hundred microfarads. When the filter capacitor in this circuit fails, the reference voltage drops. This causes the integrated circuit in the SMPS to increase the pulse width to the MOSFET, boosting up the output voltage to a level that is much higher than normal. Naturally, this trips the X-ray protection circuit and causes a high-voltage shutdown in order to prevent excessive radiation.

In the November 2002 issue we looked at a similar result (over-voltage) caused by a bad optical coupler. Kortek had received a bad batch of the opto-isolators. The nature of the failure was that the transfer rate was bad and that fooled the SMPS into thinking that the B+ output voltage was too low. The PWM controller IC responded by raising the B+ voltage. As the B+ rose, the current in deflection circuits increased, resulting in a picture that was "overscanned." The edges of the raster extended beyond the edges of the CRT. The picture appeared "overscanned" in all dimensions. As the entire picture became intermittently larger, this symptom was referred to as "blooming" as the raster seemed to bloom outwards from the center of the CRT. Eventually, the B+ would rise to the point that the X-ray protection kicked in, causing the monitor to black out completely.

Another failure that can trip the X-ray protector may be in the bypass capacitor that removes spikes from the horizontal output circuit (Slot Tech Magazine, October 2002).

The noise generated by the horizontal output transistor (and the rest of the horizontal output circuit in a monitor) takes the form of huge voltage spikes that can easily reach +160 volts or more. Since the horizontal output stage of a monitor is directly powered by the B+, these voltage spikes will travel along with the B+ to other circuits and can really mess up the monitor!

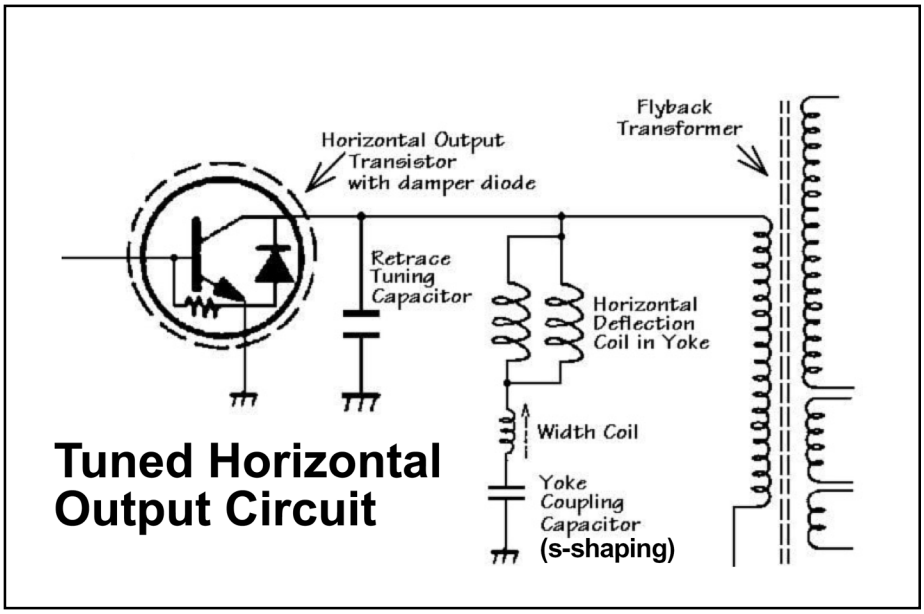
The bypass capacitor filters out the voltage spikes to prevent them from affecting the rest of the monitor circuits. It absorbs the spikes, passing them to ground.

When this capacitor fails, the voltage spikes are delivered, full force, to the rest of the monitor circuits, including the X-ray protector. In this case, the voltage spike exceeds the Zener voltage, tripping the X-ray protector and shutting down the monitor, even though there was no real threat of X-rays. Just a little something extra, thrown in there to make life a challenge for inexperienced technicians.

LC Circuits

If you are still having problems with high EHT tripping the X-ray protector, you might have one of the hardest of all problems to diagnose in a monitor; you might have a de-tuned horizontal output circuit.

The horizontal output circuit is a tuned circuit. It consists



of five basic parts: The retrace tuning capacitor, the pair of horizontal coils in the deflection yoke, the width coil, the yoke coupling (also known a the "S shaping") capacitor and the flyback transformer in the integrated high voltage transformer (IHVT) which is also known as the high voltage unit. The operation of the horizontal output circuit was covered in December 2002. What wasn't covered is an admittedly rare condition when one of these components doesn't fail completely but rather shifts its value or "quality" somehow.

You see, the horizontal output circuit is a tricky little devil. Because it's a tuned circuit, it's designed to operate most efficiently at a specific frequency. For example, in a VGA resolution monitor, the horizontal frequency is around 31.5 kHz. The coils in the deflection yoke and the retrace tuning capacitor(s) form what's known as an LC "tank." A tank is a capacitor in parallel with a coil. The electronic abbreviation for coil the letter "L." C means capacitor, of course.

In a tank circuit, the inductance of the coil and the capacitance of the capacitor are chosen carefully by the design engineer to resonate at exactly the horizontal frequency. If either of the values changes (due to age or some type of failure), the naturally resonate frequency of the tank changes.

There is another LC circuit at work here as well. It's the width coil in series with the S shaping capacitor. In this case, it's also designed to work at a specific frequency but it doesn't resonate. In a series LC circuit, the inductive reactance of the coil (a coil is also known as an "inductor") is canceled out by the capacitive reactance of the capacitor. That's right! In a perfectly tuned series LC circuit where the capacitive and inductive reactance are equal, the two components actually cancel each other out and, electronically speaking, disappear! When the value of either component changes, the subtractive difference of the two values will change as well. They will either cancel out more of each other's inductance (creating a lower total impedance) or not cancel enough of each other's inductance, causing the total impedance to rise.

Even the smallest change in value can create a big change in the total impedance of a series LC circuit or the resonate frequency of a tank. However, regardless of any change in the tank or the LC series circuit, the horizontal output circuit is still being driven by the normal, proper frequency. This frequency is determined by the horizontal oscillator and the sync signal that comes from the game PCB, both of which are, presumably, still operating normally.

This can cause all kinds of problems, including a substantial rise in EHT voltage even though the B+ power supply is perfectly normal! In this case, the cause might be a drop in value of one or more retrace tuning capacitor(s). They're easy to find because they're in parallel with the horizontal output transistor. There may be two, three or even four of these in parallel here. This is where you have to be careful because the value, which is usually expressed in picofarads (3900 to 5600 is typical), can vary quite a bit depending on the size of the CRT and the operating frequency of the horizontal deflection circuit. Two chassis that look otherwise identical can have a wide range of different values here.

Use a good capacitance meter to ferret out a drop in capacitance or try replacing them. Since it's such a rare failure, you're likely to have a junk chassis with these components still on it.

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Schedule of Events

Events subject to change

Tuesday, March 4th, 2003

9:00 am - 12:00pm
How Monitors Work - Part 1
Theory of Operation - Beginning level

12:00pm - 1:15pm Luncheon

1:15pm - 3:15pm
MEI - BV troubleshooting and repair

3:30pm - 5:30pm
Seiko Printers

Wednesday, March 5th, 2003

9:00 am - 12:00pm
How Monitors Work - Part 2
Narrow Down the Problem - Intermediate Level

12:00pm - 1:15 pm Luncheon

1:15pm - 3:15pm
Asahi Seiko - Hopper troubleshooting and repair

3:30pm - 5:30pm
Coin Mechanisms, Inc. - Coin Comparitor technology and repair.

Thursday, March 6th, 2003

9:00 am - 12:00pm
How Monitors Work - Part 3
Circuit Analysis and Component Level Troubleshooting - Advanced Level

12:00pm - 1:15 pm Luncheon

1:15pm - 3:15pm
Sencore - Monitor Troubleshooting and Repair - Using sophisticated test equipment.

3:30pm - 5:30pm
JCM Bill Validators -
BV troubleshooting and repair

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