Above: Sherry Daniel of Meskwaki Bingo*Casino*Hotel in Tama IA, runs through the RAM Clear and machine setup procedure on WMS Gaming's Bluebird machine. Tech trainer Randall Henderson gave the presentation at TechFest 11.

June 2005

Slot Tech Editorial

Summer's here and things are hot in San Diego, California. Sometimes, heat is a good thing. Sometimes it's not. A case in point is SMD rework. Surface Mount Devices are the tiny miracles of modern electronics that have found their way into almost everything we use today. The gaming industry is full of equipment that uses SMDs. The new Tovis monitor that we've been discussing for the past six months is full of 'em, tacked to the underside of the PCB.

Excess heat is not good when it comes to removing and replacing SMDs. Traditional methods for SMD rework include hot air (convection) and hot tweezers (conduction) both of which are really unsuited to the type of SMD rework we're likely to encounter in a casino. We're looking for an inexpensive alternative to costly SMD rework stations as well as a method that is safe to use without fear of damaging the PCB or the device itself.

Enter Chip Quick to the rescue. This product represents a completely different paradigm in SMD rework, using a low-temperature metal alloy and some really cool flux to do the job, you can remove and replace SMDs with ease and in complete safety. It's just the solution that casinos are looking for that occasional SMD rework job. Read "Practical SMD Rework" beginning on page 16.

This month, we take a look at the vertical output circuit of the Tovis digital monitor. This circuit isn't digital but it still has a little something different going for it. The story continues on page 31.

Herschel Peeler has a nice little power supply troubleshooting guide for us this month. As usual, he has the leadoff position in the magazine.

I am sorry to report that Slot Tech Magazine's resident slot math guru, John Wilson, was unable to contribute to Slot Tech Magazine this month due to pressing family obligations. I wish him and his family all the best.

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

Randy Fromm

TechFest 12 will be held someplace Nice October 11-13 2005

Randy Fromm's Slot Tech Magazine

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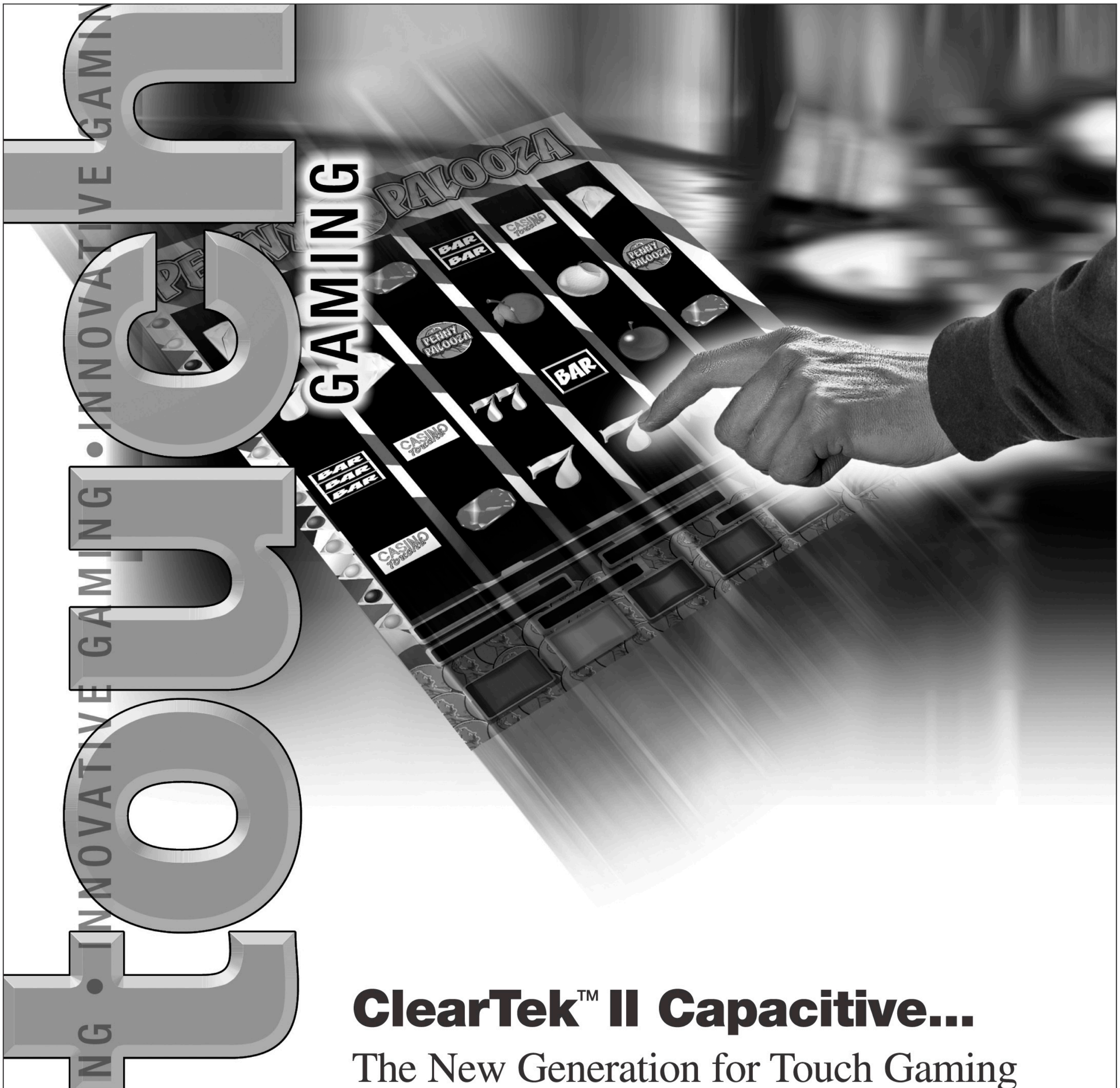

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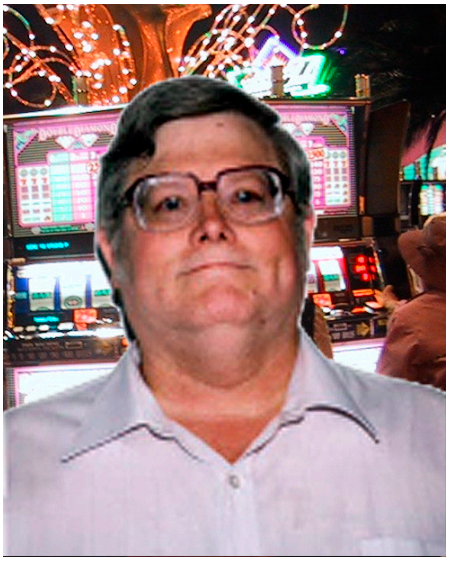

Power Supplies are a Pain in the AC!

By Herschel Peeler

It's been Power Supply week where I work. We have accumulated shelves full of various power supplies over the last year or so. We spend most of our time working on monitors and seldom get around to working on power supplies. Last week we took the time to do them.

Typically, these assemblies are not made by the vendor of the game. They are just an assembly that they purchase. They often don't have schematics or parts for them. Yes, that's a general statement. There are exceptions.

Repairs are typically quick but one in a dozen gets a really interesting problem. Most of them are a straightforward switching power supply design and have a lot in common with one another (see illustration, overleaf). They get their input from the AC line, fuse it, filter it, rectify it to get a high voltage DC (around +160 VDC, typically) and chop that back into pulsating DC at a high frequency by using a switching transistor. What they gain here is a more efficient system and a smaller power transformer. A 60 Hz power transformer makes a good boat anchor. They are huge, heavy and expensive. As the operating frequency rises, inductance changes, the transformer's core material changes from heavy, laminated Iron to lightweight Ferrite and we can make a transformer for the same power level that fits in the palm of our hand.

Our chopped up high voltage pulsating DC drives the primary of the power transformer. The transformer secondary circuits look much the same as they would for a 60 Hz circuit with the exception of the rectifiers. The rectifiers must be capable of rectifying the higher frequency so they are typically Fast Recovery diodes. By Fast Recovery, we refer to the ability to turn off fast. Regular diodes take a while for the current carriers to leave the junction of a diode. Fast Recovery diodes turn off faster. Schottky diodes are often found in these areas.

Regulation is done by monitoring the output voltage and feeding back a signal to the primary circuit so the regulator can track how the output voltage is doing. Since the primary and secondary are on different ground systems, an optoisolator is used to make this feedback circuit.

Different Grounds Between the Primary and Secondary?

An important question! The primary circuit is run off of the AC line. All the circuit from the AC Line In to the primary of the transformer is referenced to Earth ground. It is far too easy to connect yourself between a high voltage and earth ground on the scope probe, test equipment or a dozen other places. This can result in a fatal shock.

WHEN WORKING ON A SWITCHING POWER SUPPLY ON THE BENCH, ALWAYS USE AN ISOLATION TRANSFORMER TO POWER THE POWER SUPPLY BEING TESTED. This doesn't mean you can't be shocked. It just means it is less likely to be fatal.

If you take a close look at the board you can usually see the separation between the two circuits. While you are troubleshooting, be sure you reference your voltage reading to the proper ground system.

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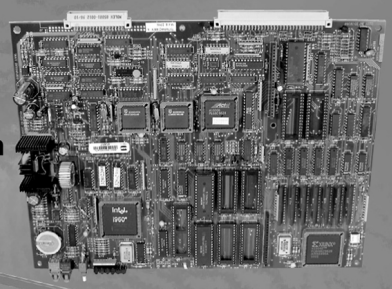

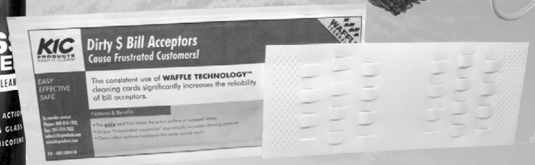

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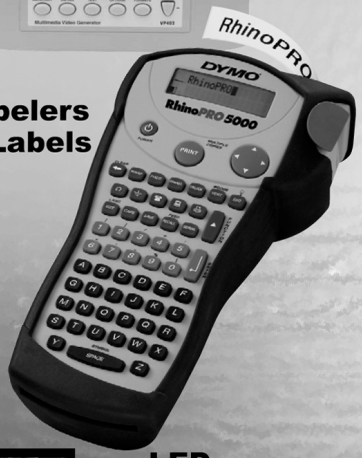

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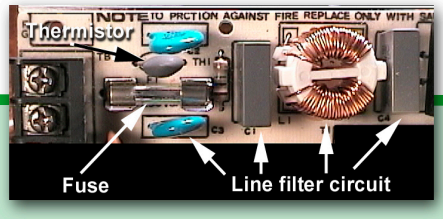

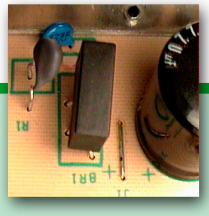

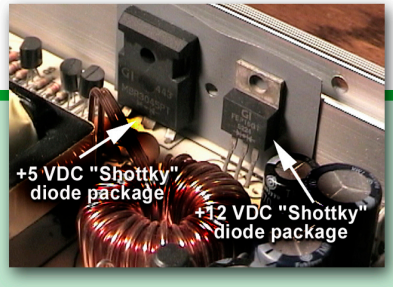

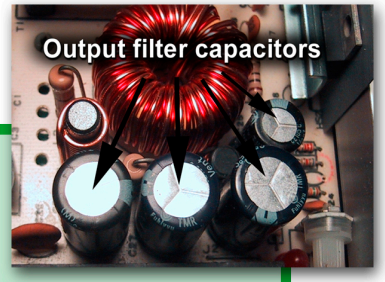

120 VAC
60 Hz

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Filter

Bridge Rectifier &
Primary Filter Capacitor

Primary Ground

Snubber Circuit

Power
Transformer

Primary

Secondary

Output Rectifiers &
Output Filter Capacitors

+

Regulated
voltage

–

Switching
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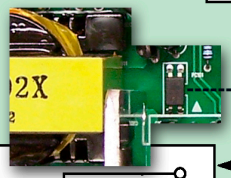

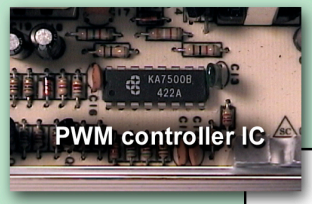

Primary Ground

Secondary Ground

Switching
control circuit
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Optoisolator

Typical low voltage power supply in a slot machine

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Different regulation methods are available. Some regulate the voltage level in the primary circuit. Some change the width of the pulses. In either case the steps of the operation are the same.

Very simple circuits that run under a fixed load may not have the feedback function. If the load is constant (like driving a fluorescent lamp) the operation may be fixed and the power supply is just designed to supply a fixed voltage at a fixed current, with no feedback from secondary to primary.

Troubleshooting, in General

Are we getting the right voltage out? Check the DC voltage level as well as with a scope to check for ripple. If the voltage is too high, our regulating system is off. If regulated through a feedback scheme, the regulator is getting incorrect feedback and it thinks that that the output is too low, driving up the output voltage to compensate. The regulator chip itself may be bad. If the output is too low, we may have a regulating problem or something may be loading down the output. Bad caps are as common here as with monitors.

Check the power supply without a load first, then with a load and see that the voltages stay within a proper level. Usually, I design a power supply test setup that runs at about half the rated capability of the power supply. I couldn't swear this to be the best method. It just gives me the option of having one general purpose Load Block to use on various power supplies.

If you get no output voltages at all, check the system at a few significant points and see in which stage the problems starts. Do we get the AC in? Does the AC get to the rectifier? Do we get a high voltage at the output of the rectifier? Is the high voltage being chopped into pulsating DC? Do we get AC out of the secondary of the transformer? Does the rectifier on the secondary have a good voltage across the filter caps?

Substituting Parts

Of course our first choice is to use the proper replacement part. We have a pretty heavy stock of replacement parts and we still get caught without the right one more often than I like.

Power transistors - At a minimum match case, pinout, voltage and current. Better... also match Gain, saturation voltage, and voltage across Emitter - Collector (or Source - Drain) at the current it is running. For switching transistors speed is important also. Match Base (or Gate) characteristics also. Higher breakdown voltage or current capability is okay as long as other characteristics are also met.

Capacitors - Equal or higher breakdown voltage as long as physical dimensions are okay. Temperature characteristics must also be met. In monitors, almost everything is rated for 105?C operation. We find these also in power supplies but not to the same extent. As long as there is sufficient cooling, 85?C parts are used. Substituting 105?C parts for 85? C parts is okay but not the other way.

Editor's note: I recommend 105?C capacitors as replacements for everything. It gets hot inside a slot machine.

Rectifiers - Match or exceed voltage and current ratings. Replace High Speed rectifiers with the same type. Most rectifiers come in a series with different breakdown voltages. It isn't necessary to stock all members of that series. Just stock the higher voltage devices. A device rated at 600 V or 1000 Volts will work fine at 50 Volts too.

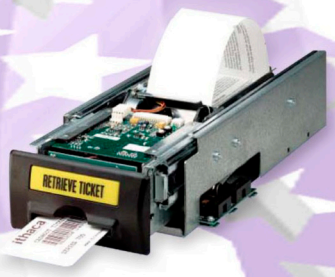
Fuses - Same current rating and type only.

Monitoring Outputs

At a minimum I suggest putting LEDs at the output of the power supplies for a quick indication of a problem while I still have my hand on the power switch. A better solution is to have a window comparator on the outputs to not just confirm that there is a voltage there, but that it is within proper limits for that output. This subject was covered in the April 2005 issue of Slot Tech Magazine.

Grounding Straps

Wear grounding straps when working on digital circuits but not power supplies or monitors. The same goes with static safe mats. They are intended for static sensitive circuits, not where you might find a high voltage.



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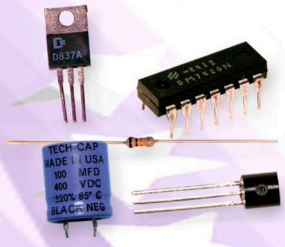

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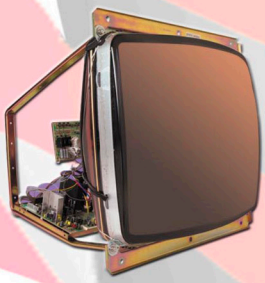

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Troubleshooting Switching Power Supplies

1. No output at all? Go to 1.1
2. Missing one or more, but not all, voltages on the secondary side. Go to 2.1
3. Fuse blows after a few seconds but no short is obvious. Go to 3.1
4. Works with no load, but not under a loaded output. Go to 4.1

1.1 Check Fuse

Fuse good, go to 1.2

Fuses don't just blow spontaneously. If the fuse blew, look for a reason before replacing the fuse and powering on again. Take a resistance measurement of the circuit where the fuse was connected. If you find a low resistance across the AC Line, putting in a new fuse is a waste of time. Most good ohmmeters (bench variety, not handheld) will make low resistance readings close enough for you to find the shorted component to within an inch or so. Typically it's the switching transistor that is shorted, but don't replace it without checking it first. Other possibilities are shorted rectifiers or (rarely) filter caps.

1.2 No output at all but the Fuse is Good

1.2.1 Check for AC at the input of the main rectifier. No AC here indicates the problem may be an open AC Line Filter, connector or board trace.

1.2.2 Check for High Voltage DC at the output of the rectifier or across the filter capacitor. These filter capacitors are easy to find even if you don't have a schematic. They are usually the biggest capacitor on the board. Hundreds of microfarads at hundreds of volts. Measure it with a meter and/or a scope.

Good voltage here, go to 1.3

1.3 No output. Good High Voltage DC

1.3.1 Check the output of the switching transistor for a high voltage pulsating DC at a high frequency.

No output here at all, go to 1.4

Occasional groups of pulses, go to 1.5

1.4 No Output, HVDC is present, no HV Pulsating DC

Open switching transistor.

Bad regulator.

Is the regulator getting power? Yes, go to 1.6.

The regulator is usually powered from two sources. One from the HVDC to get the regulator circuit started and a second from a winding on the transformer. Read the data sheet on the regulator used in the circuit and see what its needs are.

Is the regulator being shut down from a feedback circuit? Many power supplies sense an over voltage (or under voltage) condition in another circuit to shut down the voltage regulator. An example of this would be the X-Ray circuit in a monitor. Too high an Anode voltage is sensed and the voltage regulator is shut down.

1.5 No Output, HVDC is present, occasional pulses of HV Pulsating DC.

Typically this is an indication that the power supply is trying to come up, sensing an error condition and shutting back down. This may often be accompanied by a high-pitched squeal.

Typically this is a problem on one of the outputs. A shorted rectifier or filter capacitor. Thermal troubleshooting techniques often help. Look for what gets hot first.

2.1 Missing an output voltage

If one or more outputs are working but not all, the problem is likely to be in the bad circuits alone. Something from the secondary winding out to the output of that power supply. Often more than one output may originate from a single winding of the transformer, so multiple outputs may be related.

Is it coming out of the transformer as a good AC signal?

Is it getting rectified?

Is it getting filtered?

Is there a regulator between the rectifier and the output?

Do all the board traces look okay?

3.1 Intermittent or thermal problem.

Clean the board with a brush or mild soap and water. Make sure the board is dried completely. Paint the board white with freeze spray in the area that is getting hot. Apply power and see what thaws out first.

What thaws out first may not be the actual bad part. The bad part may be what is causing the part to get hot. But this technique will get you down to a few components you can check.

4.1 Appears to be okay with no load but outputs drag down when placed under a load.

If all supplies are involved the problem is likely to be in the main regulator. If only one output is bad the problem might be a regulator associated with that circuit only.

Open filter capacitor - The load current is drawn from the filter capacitor in normal operation. With no load even a leaky filter capacitor may appear okay. As you add a load the capacitor cannot keep up with the load and the problem becomes apparent.

Ideally test a power supply under full load. I confess, I don't. I usually run them at about 50% of the full load. A 300 Watt power supply will throw off more heat than...well, is safe to have lying on the bench.

Herschel Peeler
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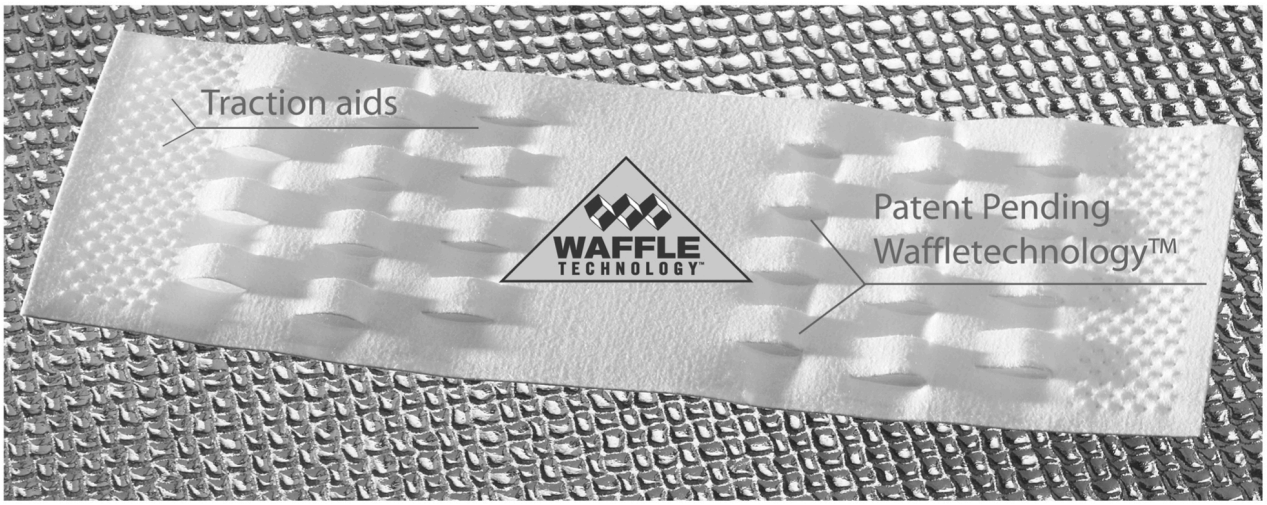

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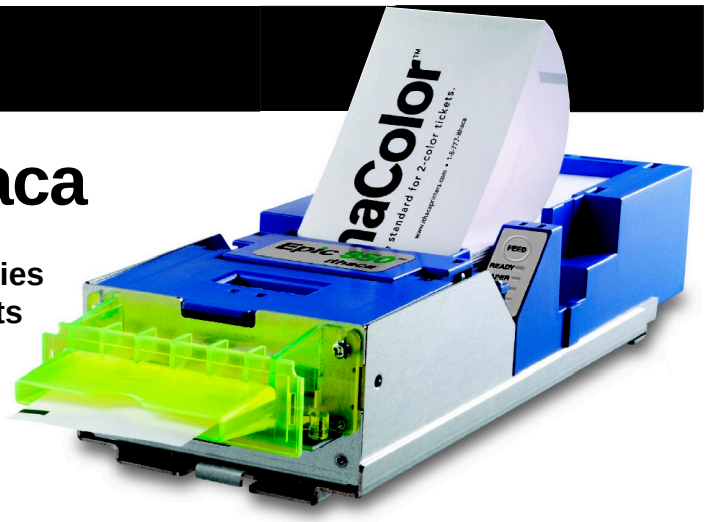
Wynn Resorts Selects TransAct Technologies as Sole Provider of Gaming Printers For Its Newly Opened Las Vegas Hotel Casino



TransAct Technologies Incorporated has announced that Wynn Resorts has selected TransAct Technologies to be the sole provider of gaming printers for its Wynn Las Vegas resort, which celebrated its grand opening on April 28.

According to Transact, Wynn Las Vegas extensively reviewed all printer solutions available and found that TransAct offered the most advanced technology in emerging products and the strongest track record of performance on their legacy products. Ultimately, Wynn chose TransAct's Ithaca line of printers because of the advanced solutions being offered within the new Epic950.

"The opening has gone exceptionally well from our standpoint. The performance of the Epic 950 has been outstanding," said Jon Berkley, Senior Vice President of Global Gaming and Lottery for TransAct. "It is an honor to have the Epic950 selected as the printer of choice by Wynn, a customer known to demand nothing but the best. As they have done in the past, the Wynn group is pushing the edge of the envelope in terms of what the future of gaming can be and has considered new ways to enhance the gaming experience. With the Epic950 on their floor, Wynn Las Vegas will have the ability to drive new technology and to bring advancements like color, promotional couponing and real time customer interaction to slot players on the floor."

Wynn Las Vegas, a $2.7 billion resort and casino located on approximately 217 acres on the Las Vegas Strip, is considered by many to be the most impactful casino opening in many years. Steve Wynn has a reputation as a visionary within the gaming industry and the opening of Wynn Las Vegas is viewed as a signal of what is to come in the gaming industry. Wynn Las Vegas was the first casino to globally implement this advanced printing technology with their slot machines.

Bart C. Shuldman, Chairman, President and Chief Executive Officer of TransAct Technologies, said, "Having TransAct equip the new Wynn Las Vegas casino with our Epic 950 is a testament to the quality and functionality of our printers. Industry leaders like Wynn Resorts realize the importance of the customer gaming experience, as well as the potential to expand their marketing strategies. Our latest innovation, the Epic 950 printer, provides an 'all-in-one' solution with its advanced printing technology and design."

Selected by Austrian Gaming Industries

Technologies Incorporated has also announced that Austrian Gaming Industries GmbH (AGI) has selected the Ithaca Epic 950 as a preferred thermal ticket printer for AGI's full range of gaming platforms and slot machines.

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"Similar to what we are achieving in the U.S., our Epic 950 printer is gaining traction in Europe because of its increased functionality and technologies and because we back each sale up with a dedicated service and support network that differentiates TransAct," said Bart C. Shuldman, Chairman, President and Chief Executive Officer of TransAct Technologies.

"We are pleased to select TransAct's Epic 950 as a preferred printer across AGI's full range of gaming platforms," said Jens Halle, Managing Director of AGI. "TransAct was the clear choice for us after extensive testing and because both of our organizations share in a philosophy of product excellence and integrity. Ticket-in/ticket-out technology is currently big news at our European gaming operations. By integrating TransAct's printer, we can now satisfy this market with the latest AGI products, like our Multi-Gaminator. Finally, TransAct's Epic 950 delivers the critical security and reliability we require to be successful."

New Support Department for Heber Limited

Customer support is a major element of the package that Heber Limited, manufacturers of electronic control systems, offers its customers. This service has been developed further by the creation of a specific Product Support Services Department.

The purpose of this department is to provide detailed technical support to customers as well as offering product training programmes and comprehensive support documentation and manuals to potential customers.

Not only will the department provide support externally to customers, it will be a great source of information and resources internally. This will include providing the links between Sales and Engineering and throughout other departments within the company.

(L to R) Andrew Laws (Technical Author), Richard Horne (Product Support Supervisor) and Roger Fenton (Customer Support Engineer)

The department was initially formed with three members of staff, and due to its success, has already recruited a fourth member, appointed to start in June.

"Customer support is something that Heber Limited prides itself on," said Richard Horne, Product Support Supervisor. "We also consider it as an ongoing process of improvement. By the creation of this new department we can continue to maintain our high level of support, as our customer and product base grows."

For further information about Heber Limited visit www.heber.co.uk or phone +44 (0) 1453 886000.

Unicum Delivers More Games to the International Market

Unicum Group has released two new international slot titles for its latest gaming platform, Unicum Adventures. Both games have come out in English; their Russian versions will premier at Slot Revolution forum that will take place in Moscow on June 1.

The first game "Around the World" is based on a famous adventure story which provides a striking combination of captive gameplay, two exciting bonuses and a "Beat the Dealer" feature. All top events in the game are based on themes which are well-known to the player and bring him additional comfort and engagement in the game play.

Red Hot Hockey Peppers is Unicum's first sports-themed game that will strike a chord with hockey fans. It is a story of red and green peppers stuffed with two bonus features, free spins and a double-up option. The player is granted a role of a coach and takes advantage of the bonus games and raises the team budget with favourable gambling conditions, based on player- and operator-oriented math.

"Unicum's development and production capacities have grown considerably and now we are ready to deliver a range of industry standard product," commented Peter Moffitt, Unicum's R&D Vice President. "Today we provide 'strictly-Russian' games to the domestic market and work on international titles with well-known themes, flexible gaming settings and quality technology. Unicum will surprise the world operator community with more competitive products in the very near future! We focus on more entertaining games that will be interesting to people in many different countries."

Unicum started building its international portfolio in 2004 with the launch of the company's first platform Adventures. The first three games, Russian Mafia, Gold of Slavs and Papyrus, developed for Russian and world markets, were introduced to operators at ICE 2005. Today the company plans to enrich its current platform library with a dozen new multilingual games by the end of the year.

Practical SMD Rework

By Marv Cohen

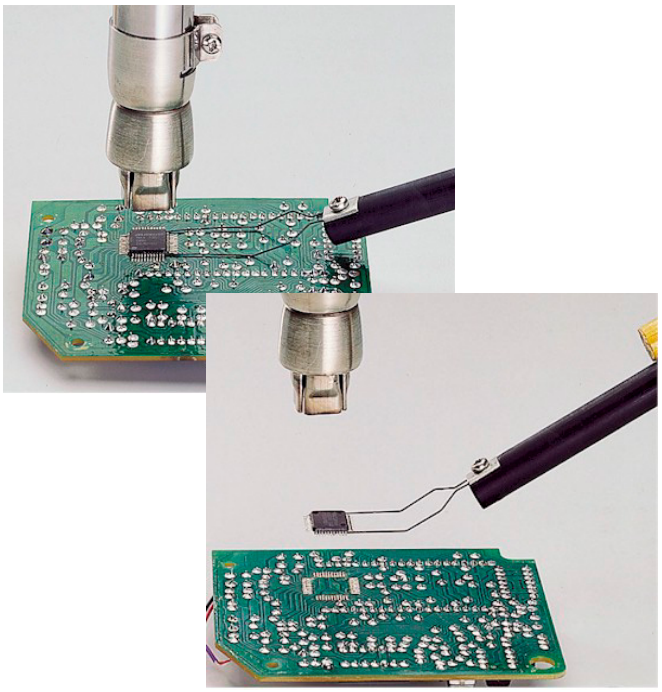
Slot Machine technicians are continuously faced with the challenge of repairing circuit boards. The old days of the soldering iron, solder sucker and solder braid are no longer the solution that we could always depend on. Soon, through-hole components will be history. We are now faced with a new challenge called SMT (surface mount technology). Now is the time to improve our rework techniques on SMDs (Surface Mounted Devices). The SMD has been a major step in miniaturization of modern circuit boards.

A typical SMD may have as few as 2 pins or as many as 300 or more. The more leads, the finer the pitch (distance between pins). Each SMD pin is connected to a pad on the board, forming a pin pad solder connection. To remove a typical SMD we must simultaneously heat all the pin pad connections into a molten state long enough to lift off the chip. If one or more pins does not release, a pad will be pulled from the board. Once this occurs, the board may fall into the trash category. As technicians, our job is to repair and save boards. We need to begin by developing SMD methods that work best for us.

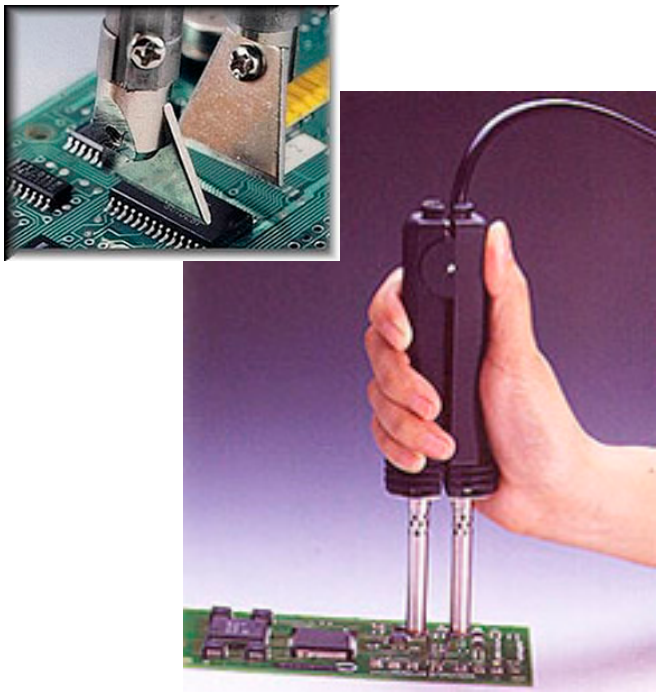
Rework Inflicted by Rework

Modern PCBs (printed circuits boards) are densely spaced with SMDs and are sometimes double sided with multi-layers. The pads (lands) on the circuit board are only held down by an adhesive. If the

Traditional SMD Rework Methods



Left: SMD rework by convection heating uses a hot air tip to heat all of the pins of the device at once. A pick is then used to lift the device from the PCB.



Right: SMD rework by conduction heating uses heated "tweezers" to heat all of the pins at once.

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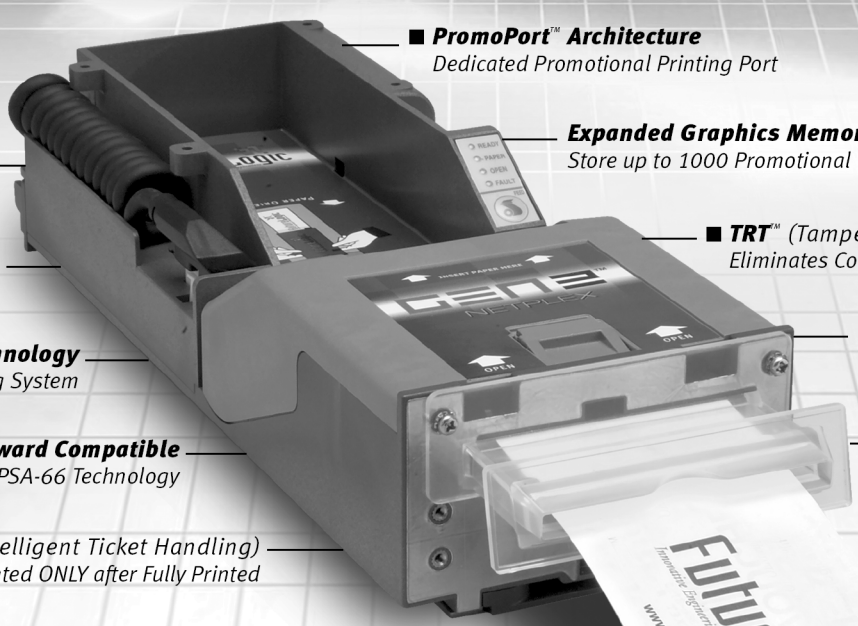

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As evidenced by the "Top 20 Most Innovative New Gaming Products" award, when it comes to cashless gaming printers, FutureLogic's GEN2™ sets the bar for all. As the only gaming printer recognized for excellence, GEN2 is not just another "ME-TOO" printer, it is *the standard*.

Slot manufacturers concur. For the past several years, FutureLogic printers have remained the choice printer for Ainsworth, Aristocrat, Atronic, Bally, Cirsa, IGT, Mikohn, ShuffleMaster, Spielo, and WMS Gaming.

Now it's your turn to decide. Make GEN2, *your standard*.

2003 GEN2™ TOP 20 Most Innovative New Gaming Products — Casino Journal

2004 GEN2™ TOP 20 Most Innovative New Gaming Products — Casino Journal

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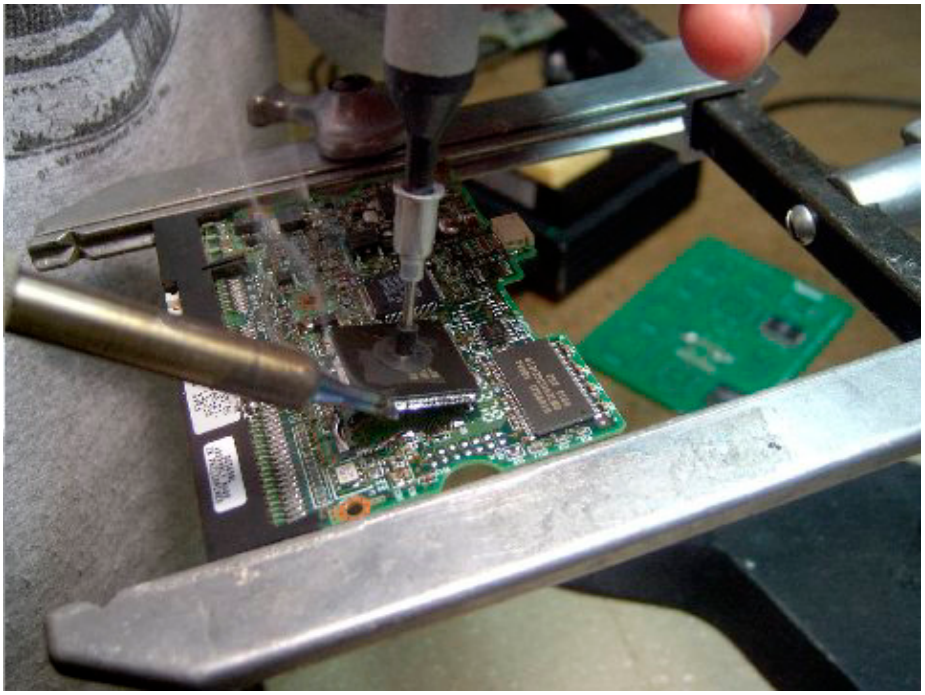
soldering iron is set at too high a temperature for too long a period of time, the pads will lift from the board. Blowing hot air on the chip for too long a period of time will also cause pad lifting, adjacent component damage, releasing of underside components and board delamination. The solution to preventing damage to the PCB will require a careful selection of tools and a safe practical method. Heat causes damage.

Traditional Rework Methods

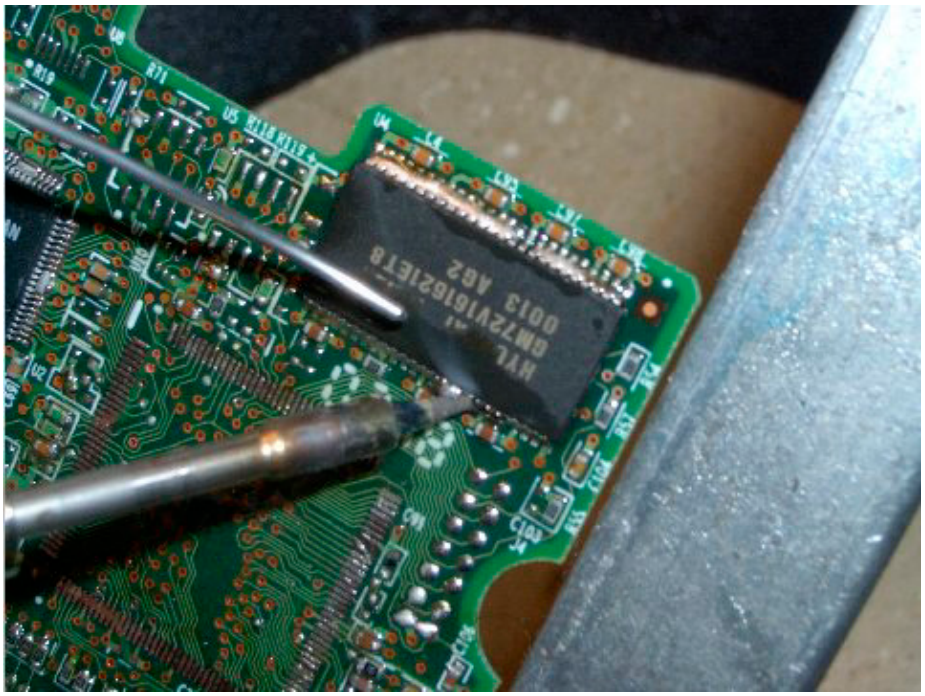
Today's slot tech needs a method to solder and unsolder that is safe and affordable for low volume rework. Traditionally, the most common methods of rework have been conduction and convection.

Conduction is the use of a soldering head that fits over the SMD and applies heat simultaneously to all the pins. The disadvantage is that the iron has to be set at a high temperature and there is no way seeing or knowing when to lift off the chip. Also, a large inventory of tips is needed for the many SMD configurations. If repeating the same procedure, you can develop a method to duplicate results called profiling. This method is not practical for occasional rework.

Convection is the use of focused hot air through a nozzle shaped to the SMD. With convection, the heat transfer to the pins takes longer and some of the heat goes to the adjacent components if they are not shielded. Also, the longer duration of heat increases the risk of releasing the underside components and board de-lamination. This method also requires a large inventory of expensive tips. When performing the exact same procedure again and again, a profile can be set up to duplicate results. The conduction and convection methods are only good for high volume rework where a safe proven profile of temperature, time, heat shielding and tip can be set up.



The Chip Quick alloy's low melting point allows the solder on all of the pins to remain molten while the device is picked off the PCB with a vacuum pick.



Adding the Chip Quick alloy to the pins of the device to be removed.

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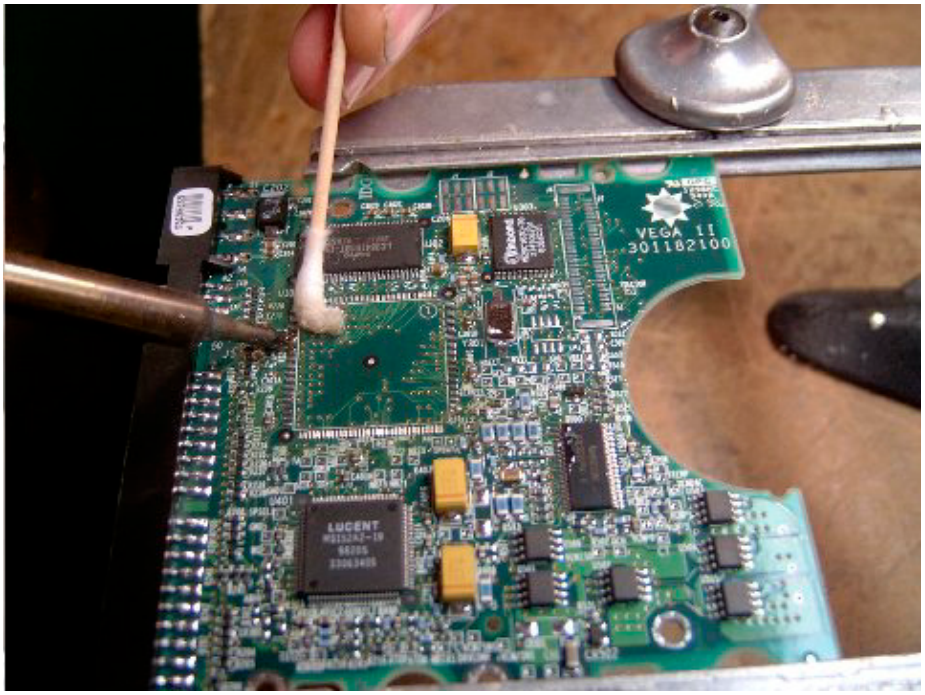
However, most slot techs are looking for a fast, safe and affordable method that doesn't require special equipment. In the real world of slot machine repair, we have dozens of different problems and we are not always replacing the same component again and again.

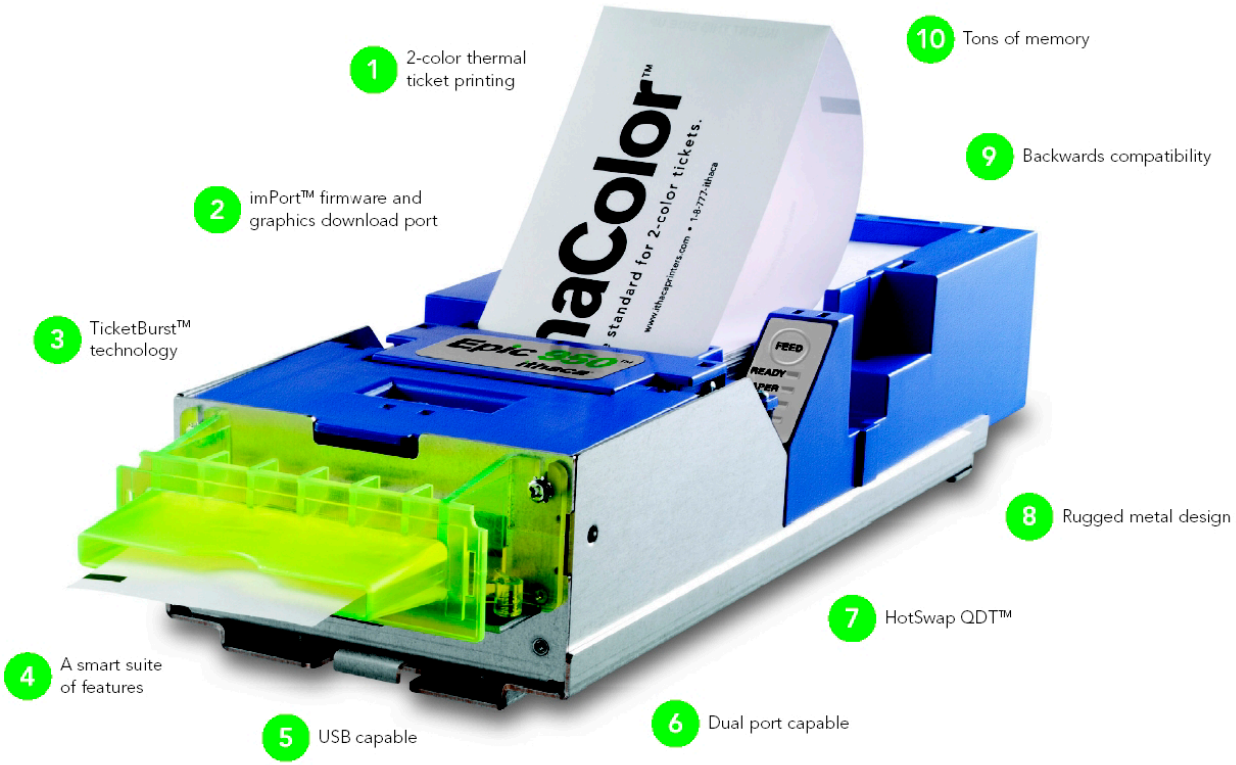
A Practical Solder/Desolder Rework Method That Works!

DESOLDER: The most difficult part of rework has always been the safe removal of the SMD from the PCB. Soldering back on the new chip does require a certain skill that most of us can develop. A safe SMD removal solution has long been needed. The Chip Quik® SMD Removal Kit is a patented product that has revolutionized the rework industry. Even those that have never done rework can feel comfortable with this unique method. Now you can remove SMDs safely and easily with a regular soldering iron. The Chip Quik® SMD Removal Kit consists of a low temperature removal alloy in wire form with excellent wetting ability that melts at 136°F (58°C). When melted into the existing SMD connections with a solder iron, the alloy fuses into the interconnect alloy and the two combine to form a new alloy with a melting temperature below 200°F. With this lower melting temperature and an increase in thermal mass, the new alloy remains in a molten state long enough to safely remove the chip. While the solder iron temperature is not critical, 550°F or lower is recommended. At this low temperature, all potential damage is eliminated. Cleaning of the pads before installing the new chip is important. To clean the pads, use a soldering iron to apply heat while polishing each pad with a swab dipped in flux until thoroughly clean.



Cleaning of the pads before installing the new chip is important. To clean the pads, use a soldering iron to apply heat while polishing each pad with a swab dipped in flux until thoroughly clean.

Clean pads - Ready for the new device to be installed!



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Chip Quik® Instructions (supplied with kit)

SMD Removal & Cleanup

* Apply flux to all leads with syringe
* While molten use a cotton swab and flux
* Melt Chip Quik® uniformly on all pins to wipe excess off pads.
* Maintain alloy in molten state long enough
*While applying heat, polish each pad with a swab and flux until thoroughly clean
* Lift chip from board with pick-tool
*Clean residue with alcohol pad
*You are now ready to install the new chip

Prepare to Install the SMD

When replacing an SMD, the correct choice of equipment and materials will determine the quality of your work. Recommended items needed to correctly solder on an SMD are:

Soldering Iron: Very important and often neglected. The iron should always maintain a set temperature. This means that when you place the iron into the solder joint (thermal load), the temperature must stay constant at all times. In a quality iron, this specification is called thermal recovery. When using a poor quality iron, the tip temperature will cycle up and down while the solder joint is being formed. The time it takes to complete the solder joint (dwell time) will determine the quality of the joint and the amount of potential inflicted damage. Effectively, by using a quality solder iron, the temperature can be set at much lower.

Solder Tip: Use an angle chisel tip wide enough to cover the leads being soldered. Make sure tip is always tinned and clean for better heat transfer. A separate tip for soldering and desoldering is recommended.

Solder: Use 63/37 solder without rosin core and about .030 in. diameter. This solder is eutectic, meaning it liquefies and solidifies at the same temperature. Also the chance of leaving non-activated flux is eliminated.

Flux: Use a good, no-clean rework paste flux. Most rework fluxes are non-corrosive, non-conductive, have excellent wetting characteristics and tend to keep the SMD from sliding on the pads. Flux is a very important part of SMD rework for both soldering and desoldering.

Ready to Install the SMD

Now that you have carefully selected all the recommended items, we are ready to solder the SMD to the circuit board. Inspect all the pads to make sure they are all clean and equal in height. With the syringe, apply a thin bead of tack flux along all the pads. With a Vac-Pen, pick and place the SMD on the pads right into the flux, making sure that pin #1 is aligned with the correct pad. Use magnification with good lighting to make sure the pin pad alignment is perfectly centered on all sides of the SMD. The tack flux helps to keep the SMD from moving out of place. Hold down SMD firmly with a dental pick so it will not move.

Now you are ready to solder. Set the solder iron to 600°F. Tin the tip and carefully tack down three or four locations. Check pin pad location once more for this is your last chance to make a correction. Now, drag solder by holding the iron at a 45° angle as you slowly run the iron along the pins while adding solder and flux as required. You can watch each solder joint as it is being formed. If you create a solder bridge, use solder braid to remove it. Clean area with an acid brush and isopropyl alcohol. Inspect your work.

With a little practice, you can master and perfect this technique. The best part is, you can do your own rework and prevent expensive boards from becoming trash. Happy Rework!

Marv Cohen
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- Power Supply
- Backlight CCFL
- DC to AC Converter
- Digital Signal Processing
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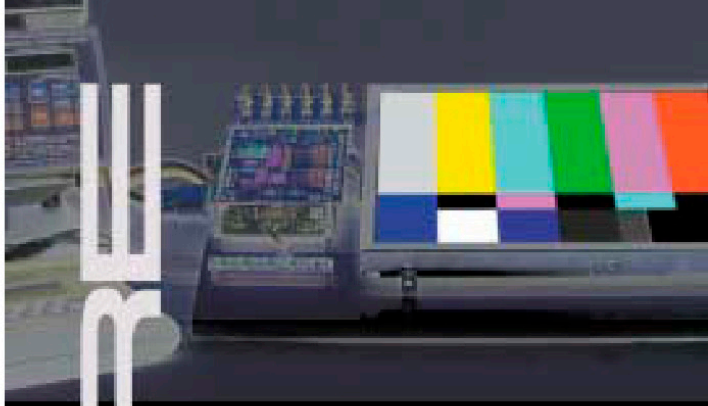

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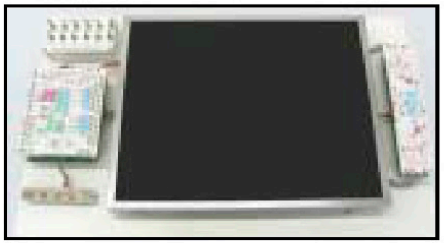
Today's LCD panels have greatly improved (and continue to improve) and are beginning to rival CRT's in most performance areas. In terms of size, weight, and power consumption LCD displays are far superior to their old CRT counterparts.

This comprehensive hands-on program covers troubleshooting and calibration concepts and techniques for LCD display types.

The course you have asked for!

What Will You Learn in this 3 Day Tech School?

- *Understand and apply safe servicing techniques*
- *Use test equipment to performance test and troubleshoot LCD monitors (SC3100, PSL60, VP401, LC103, CP5000U)*
- *Understand how to thoroughly performance test an LCD computer monitor*
- *Be familiar with switch mode power supply (SMPS) and LCD Inverter power supply operation and troubleshooting*
- *Relate SMPS and Inverter power supply block diagram test points to the equivalent schematic test point*
- *Understand multi-mode formats and circuit operation*



- *Understand analog (RGB) and digital signal formats and connectors (DVI)*
- *Explain the advantages and limitations of CRT vs. LCD displays*
- *Understand the theory and operation of fixed pixel displays, including LCD panel operation, signal processing, and backlighting*
- *Perform an LCD backlight replacement*
- *Perform LCD video calibration , including chromaticity (color temperature), black level, white level and geometry*

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The course begins with equipment familiarization and an overview of LCD displays. Students will discover how LCD panels work by learning the major functional blocks of an LCD monitor. Sencore has developed specific LCD trainers for hands –on demonstrations and troubleshooting exercises.

DAY 2

Hands-On LCD Monitor Troubleshooting

The second day of this course provides an introduction to troubleshooting LCD monitors. Entry level technicians and seasoned veterans will learn troubleshooting techniques and short cuts by using block diagrams and hands – on lab exercises.

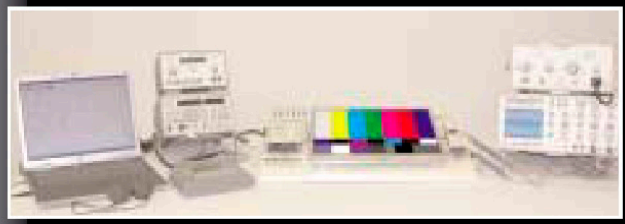
DAY 3

LCD Inverter power supply and SMPS Troubleshooting

The last day of the course provides an introduction to power supplies and their uses. The students then learn how each type of SMPS and inverter power supply works by performing experiments on a working model. This course is truly a hands-on course with approximately 70% devoted to lab time performing tests utilizing an exclusive Sencore power supply trainer.

Students will also be presented with Certificates of Completion following the Tech School.

This course is eligible for Continuing Education Credits (CEU).



Slot Tech Press Release

FutureLogic, Inc. has announced that two FutureLogic printers have received Top awards from Casino Journal. FutureLogic received two Top 20 awards - for the GEN2 printer and the GEN2 VST, a new vertical configuration printer designed for use with space-saving slim-top machines. Both printers incorporate ProMatrix, a flexible promotional couponing and trigger system that enables proactive marketing functions on the casino floor - by turning ordinary slot tickets into colorful, eye-catching coupons.

Casino Journal's Top 20 Most Innovative Gaming Technology Awards are considered the most prestigious honor bestowed on gaming products and services. A panel of four expert judges evaluated this year's entries and chose the 20 finalists. Attendees of the Third Annual Gaming Technology Summit (May 25-26, 2005, at Green Valley Ranch, Las Vegas) will vote for their favorite products and services from the Top 20 finalists, and platinum, gold and silver medals will be awarded to the top three technologies.

"FutureLogic is honored by the recognition of these distinguished judges and gaming executives, and proud to be in the company of industry-leading game manufacturers such as Atronic, Bally, IGT, Konami Gaming, Star Games and WMS Gaming," said Nick Micalizzi, VP Sales & Marketing of FutureLogic, Inc. "These awards represent the successful implementation of our new technology initiatives and commitment to setting new standards for reliable, multi-function ticket printers that help casino operators streamline operations and improve the overall gaming experience."

The GEN2 printer has received several gaming industry awards, including Casino Journal's Top 20 Most Innovative Gaming Technology Products 2003. At G2E 2004, the GEN2 VST printer was the only printer recognized by a panel of judges and received an award in the "Best Productivity-Enhancement Technology" category from Global Gaming Business (GGB) magazine.

FutureLogic printers are used by more than 30 gaming OEMs worldwide and are the standard default printer for International Gaming Technology. Other customers include Alliance Gaming Corp., WMS Industries Inc., Atronic Americas LLC, Aristocrat Technologies, Konami Gaming Inc., Multimedia Games Inc. and Spielo.

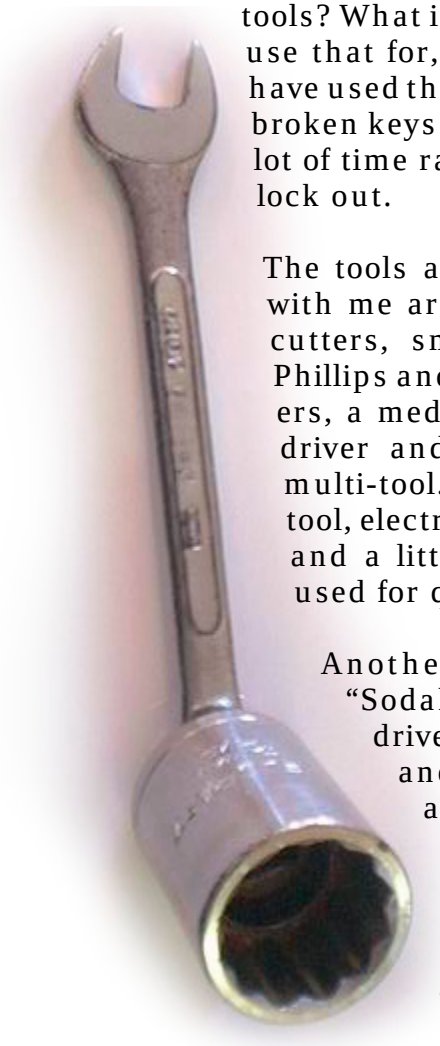
Quick & Simple Repairs #4

By Pat Porath

Some of the "tools of the trade" are quite interesting. Such as a 7/8ths sockets welded to a 7/16ths wrench; it makes the ultimate lock tool. I can't remember where I read about it, but I had six made up for our casino. They sure work great and save a lot of time installing slot door and drop door locks.

Editor's note: Pat, it was likely in the June 2002 issue of Slot Tech Magazine. Bart Holden wrote about it and provided us with a photograph.

Other tools are dental tools. Dental tools? What in the world would you use that for, you may ask. Well, I have used them many times to take broken keys out of locks. It saves a lot of time rather than drilling the lock out.



The tools and items that I carry with me are a small pair of wire cutters, small flashlight, small Phillips and small slot screwdrivers, a medium sized slot screwdriver and a Leatherman type multi-tool. I also carry a dental tool, electrical tape, a few zip ties and a little bit of heat shrink, used for quick wire repairs.

Another main tool is the "Sodak" type 4 in 1 screwdriver with a number one and number two Phillips; also a regular bit too. A few pens are also handy to carry. Not one pen, but a few (customers like them also).

Where do I carry all this stuff? Believe it or not, I found that a camera case works very well for me. It has a few little pockets in it, and it goes right on your belt. I bought mine at Wal-Mart. It is durable and works great. Well, lets get back to some slot repair.

Bally 5000 (I think there are a few out there yet) One of the most common problems with these games is the power supply. On the game display, it would be kind of scrambled or there would be no display at all. It was a big problem with the 5000 series but not all that

5 Pc. Dental Hook Set is constructed of Stainless steel and includes four assorted tips and one handle. This set is ideal for handling springs, circuit probing, micro positioning, O ring removal, etc. When tips are screwed into the handle, it is 8 3/4" long. This set also comes with a convienient pouch for storage.

5 Pc. Dental Hook Set H-S9250
Available at hobbytool.com $5.00

hard to get running again. Simply remove the power supply (located at the back of the game) and test and replace the capacitors. I would say about 90 percent of the time, simply replacing the bad caps would get it working again.

On the one end there are three pins, that is your hot, neutral, and ground. On the other end is the DC voltage. Pins 6, 7, and 8 are the ground. Pin 1 is 5vdc, pin 2 is 12vdc, and pin 3 is -12vdc. If the power supply is bad, there won't be any voltages on one or all of the pins.

Another problem that occurs on the 5000 series Bally is, after time, a game may have a lot of reel tilts. Maybe code 41, or code 42s. This may be caused by bad "O" rings. If you pull the reel off of the stepper motor, you will see six small rubber rings. When they get old and when a game is played a lot, the "O" rings get a little flat and they get hard. You can tell when they are starting to get worn in a game when after the reel spin, the reels will bounce a little bit. That is what causes the tilt. Simply replace the six "O" rings and it should cure the reel tilts. If you cannot find where to order the rings, I think WMS gaming also uses them in their reel type games.

IGT Video I-game Upright

Some of the common problems that I run into with these games are "meter disconnected" and "coin in jam." If the game is coinless, how in the world can it have a "coin in jam?" Well come to find out, one of the I/O cards (input-output cards) was loose. If you find a loose I/O card, be sure to TURN THE GAME OFF, and then secure the card. If the game isn't turned off, you can short out the board or maybe even the main processor board. Also, if some of the buttons aren't working, it may be a loose card. A "meter disconnected" error could also be caused by a loose I/O card.

Hopper problems on an I-game? Some problems could be caused by dirty or bad coin out optics. Simply clean the optics or, if that doesn't work, replace the optics. The DC motors as far as I know are very reliable. Once a great while, a wire will get disconnected. If the hopper is really acting up, a new hopper board may be needed. Only a few screws and a few connections, and it's back up and running. Player button problems? This could be caused by a bad or sticky microswitch for the specific button. It also could be caused by a loose I/O card. A loose connection in the wire harness may do it too.

The diagnostic part of the IGT I-game comes in very handy, not only for button problems but for door switches too.

When in the diagnostic menu and there is a problem with say, the "bet max" button, it will be displayed on the screen if the button isn't working at all or if the button is stuck in the ON position.

Bad micoswitches can be caused by a drink that was spilled on a game or dust and smoke buildup. A quick, simple repair that I have done a few times is to use the microswitch from the change button. If a customer is in the middle of a game and has quite a bit of money in it, they don't like to wait for a game to be fixed. I will TEMPORARILY use the microswitch from the change button and use it on say the "bet one" button. It gets the customer back playing again but BE SURE to go back to the game at a later time and REPLACE the missing change microswitch.

Sticky player buttons sometimes only need a good cleaning too. The top part pops off with a small screwdriver and the button assembly comes apart quite easily.

IGT AVP (such as the "Wheel of Fortune Special Edition and the "Fort Knox"

I have only heard of a couple problems with these type games as they are pretty new to the market. One of the problems was that the video screens were locking up in the middle of a game or in a bonus round. This was only on the "Wheel of Fortune Special Edition" games. Come to find out that the game doesn't like the "winter" scene. We disabled it in the software. On these games, the symbols and the theme changes with the seasons. I have never heard of anything like it before. What in the world next? In the fall, the games will have pumpkins and colored leaves, etc. In the winter it will have snowmen and snowflakes and around the time of New Year, it will have horns and confetti. Very wild games. I think there are something like eight different themes. Anyway, with the lockups the winter theme needed to be disabled. We disabled it and the problems went away.

On the "Fort Knox" games, the video screen "shifts" to one side. When this happens, the touch screen doesn't work properly and the bonus games don't work correctly. On the bottom part of the monitor there are some small buttons. You need to press MENU and then scroll through until you see a setting that says "factory settings". Select "factory setting" and the screen will flash for a second. Then, it should go back to center. You may also want to recalibrate the touchscreen too. This procedure works very well and cures a lot of problems. I was told that the LCD that IGT uses in the AVP is used in different games and sometimes defaults to a different game other than the AVP. I'm sure it won't be long and IGT will have the problem cured.

Newer Upright Atronic Games

A ticket didn't come out for the customer. It displays "out of paper" even though there is paper in it. A simple repair for this is to remove the current ticket out of the printer head so the bezel flashes. This way, the games knows darn well that it is out of paper. Turn the reset key once or twice then reinsert the paper. It should take it in properly. Use the reset key again and the tilt should clear; close the door of the game and the customer's ticket should print right out. With the new Atronic upright games, you DO NOT want to do a reboot unless you have to. These games take around 7 minutes to reboot. If there is some "grinding" going on when paper is inserted, a replacement printer head will be needed soon. Sometimes the main slot door pushes on the printer a little and puts strain on the printer gears. It is something to keep and eye out for. Once in a while, the screen will lock up and the customer can't cash out or play the game at all, then a reboot would be needed. Reboot the game and it usually is playable again.

IGT S-2000 No VFD display. On these games, it is very important that the VFD (vacuum florescent display) works. As far as I know, there isn't an easy way to repair them but they are easy to replace. It could be the VFD board as well. A few screws and a few connectors and they can be replaced easily. Before replacing the display, you may want to try the display board. On an upright game it is right on the door and it will have two small green lights that flash on it. Try one or the other, but it could be both.

Pat Porath
pporath@slot-techs.com

TechFest 11 Sees Bally Debut

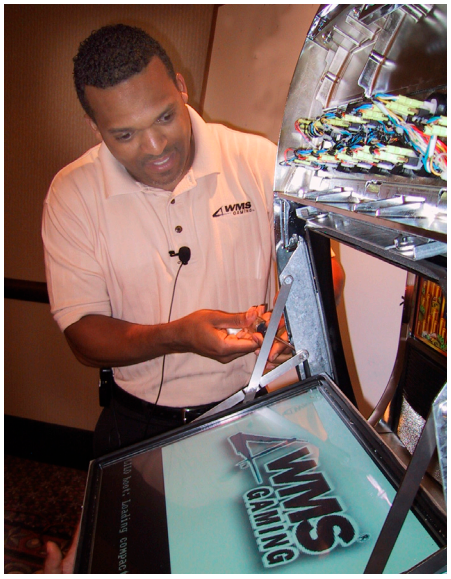
Slot machine technicians from as far away as the state of Oregon and the island nation of Aruba attended TechFest 11, which was held at the fabulous Mystic Lake Casino in Prior Lake (Minneapolis) Minnesota, May 10 - 12, 2005.

TechFest 11 placed a greater emphasis on monitor repair with the addition of a full day of training on the unique Ceronix monitor in addition to two presentations on monitor operation and repair presented by Slot Tech Magazine publisher Randy Fromm.

Other presentations included Bally Gaming + Systems' new Alpha platform and M9000 cabinet as well as a return engagement from WMS Gaming, presenting their BlueBird system.

Slot Tech Magazine gratefully acknowledges the participation of all our presenting companies.

Above: Bally Gaming + Systems' Leonard Smith presented our first look at their brand new Alpha system and the M9000 cabinet. The new cabinet has really simplified things for the slot tech, with all of the internal sub-assemblies well laid-out and easily accessible. This was Bally's premier presentation at TechFest.



Left: Wms Gaming's Randall Henderson tweaks an LCD mounting bracket during his presentation on BlueBird. The flip-down screen allows for easy adjustments during setup and other procedures that use the touchscreen. Although WMS Gaming has been a part of TechFest for some time, this was Henderson's first time as a presenter at TechFest.

Right: Another new member of the TechFest team, Ceronix's Paul Alexander, took us through a detailed circuit description and the troubleshooting procedures for Ceronix monitors. He also distributed an outstanding troubleshooting guide for Ceronix monitors which will be published in a future issue of Slot Tech Magazine.

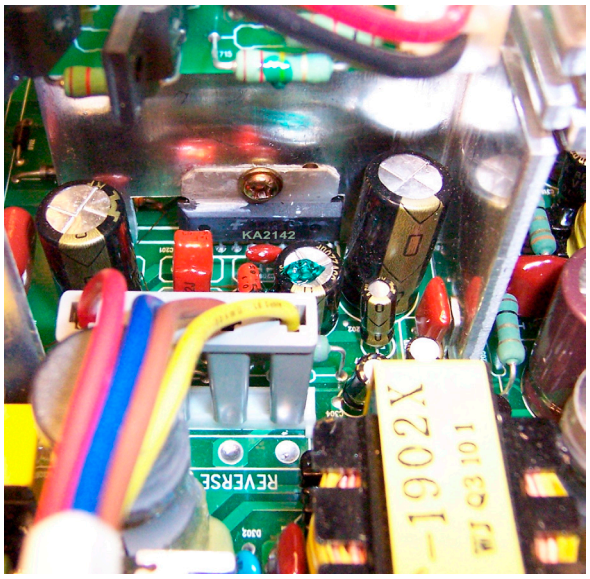
Cont' . . .

Name	Company
Allen Whiteaker	Mystic Lake Casino
Brad Shampo	Mole Lake Casino
Bradley Swanson	Mystic Lake Casino
Brian Laehn	Mohican North Star Casino
Chad DeMenge	Black Bear Casino
Charlie Borgerding	Mystic Lake Casino
Clay Jensen	Royal River Casino
Dan Schannach	Mystic Lake Casino
Dominic Gehant	Mystic Lake Casino
Elizabeth Harlan	Casino Omaha
Gary Nelson	Fortune Bay Resort Casino
George Kunth	Mole Lake Casino
Jason Babinet	Meskwaki Bingo*Casino*Hotel
Jeff Medicine Horse	Prairie Knights Casino & Resort
Jeff Swanson	Black Bear Casino
Jeffrey Croes	Hyatt Regency Aruba Resort & Casino
Jennifer McDougall	Fortune Bay Resort Casino
Joel Pelzer	Mystic Lake Casino
John Novak	Meskwaki Bingo*Casino*Hotel
John Wolling	Black Bear Casino
Jon Werner	Prairie Knights Casino & Resort
Josh Johnson	Three Rivers Casino
Josh Van Zile	Mole Lake Casino
Josh Williams	Mystic Lake Casino
Karl Rudolph	Mystic Lake Casino
Kenneth Tucker	Mohican North Star Casino
Lee Bryant	Little Six Casino
Linda Wagner	Black Bear Casino
Louis Gardner	Mohican North Star Casino
Michael Gayton	Prairie Knights Casino & Resort
Mike Stacey	Meskwaki Bingo*Casino*Hotel
Quentin Dick	Casino Omaha
Ryan Young	Isle of Capri Casino
Scott Vichaiyarath	Mystic Lake Casino
Sherry Daniel	Meskwaki Bingo*Casino*Hotel
Spencer Wolf	Meskwaki Bingo*Casino*Hotel
Susan Setter	Fortune Bay Resort Casino
Tamara “Tami” Dixon	789 Bingo & Casino
Tim Schulz	Mystic Lake Casino
Tim Sheldon	Mole Lake Casino
Timothy Schlenvogt	Black Bear Casino
Tom Dreyer	Mystic Lake Casino
Tony Moore	Mystic Lake Casino
Travis Miller	Mohican North Star Casino
Verna Prosser	Little Six Casino
Victor Swartz	Black Bear Casino
Wade Jacobson	Motor City Casino
William Cline	Casino Omaha

TOVIS

An Introduction to Digital Monitors

Part 6 - Vertical Deflection (Output)



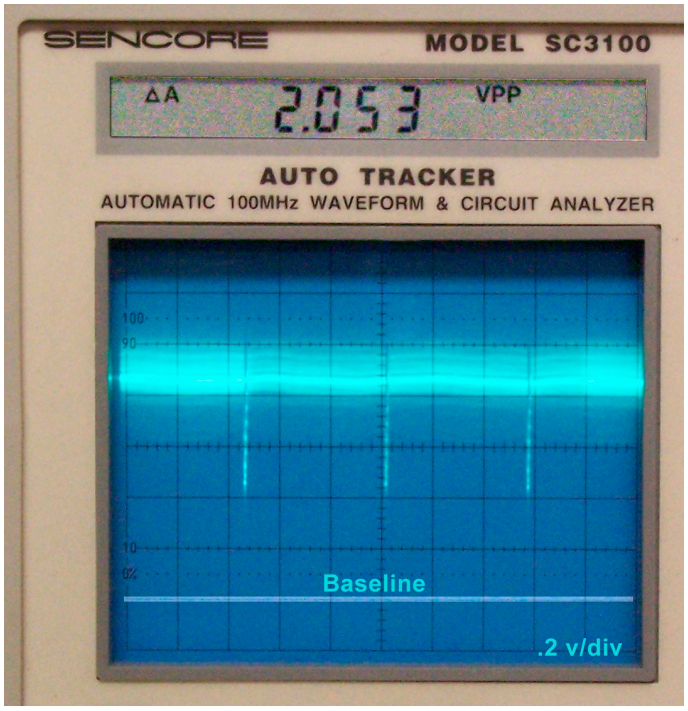
Right: Vertical output duties are handled by a KA2142. It's in a typical, single, in-line package (SIP). It has 10 pins but three of them aren't connected to anything! Here you see the device, mounted on an Aluminum heatsink, surrounded by support components, most notably, a bevy of electrolytic capacitors.

Pull out your May 2005 issue of Slot Tech Magazine because we're going to refer to the schematic diagram presented on page 34. In part 6 of our look at the Tovis digital monitor, we're going to look at IC201 (KA2142), the vertical output circuit and the "flyback generator." We're going to spend a bit of time looking at the waveforms. If you're the type that really wants to know how things work, waveform analysis tells you a lot about the operation of the circuit. On the other hand, such detailed knowledge is rarely required to actually fix things. It's easy to shotgun the entire vertical output circuit, completing the whole process in a half-hour.

It is important to understand how the flyback generator (also known as the "charge pump") works and how failures in this area can lead to destruction elsewhere. Before we take a single step in this

direction, be aware that the term "flyback" in this case has absolutely nothing to do with the same term as applied to the horizontal deflection and high voltage. In other words, we're not talking about the flyback transformer here. Sorry if you're confused. I am as well. I prefer the term "charge pump." It's also known as the "boost."

It all comes down to the voltage (with its resulting current, of course) and the waveform required by the pair of vertical deflection coils in the yoke. Look at the waveform at pin 6 of IC201. Pin 6 is the vertical output. You can see from the schematic diagram that it's connected directly to one of the terminals of the vertical deflection yoke (V-DY) at the yoke connector. You can also see from the waveform that it really doesn't take very much voltage to drive the coils. The classic, sawtooth waveform is only two divisions in amplitude. Amplitude is the height of the waveform, indicating its voltage which, at 10 volts per division is just 20 volts.

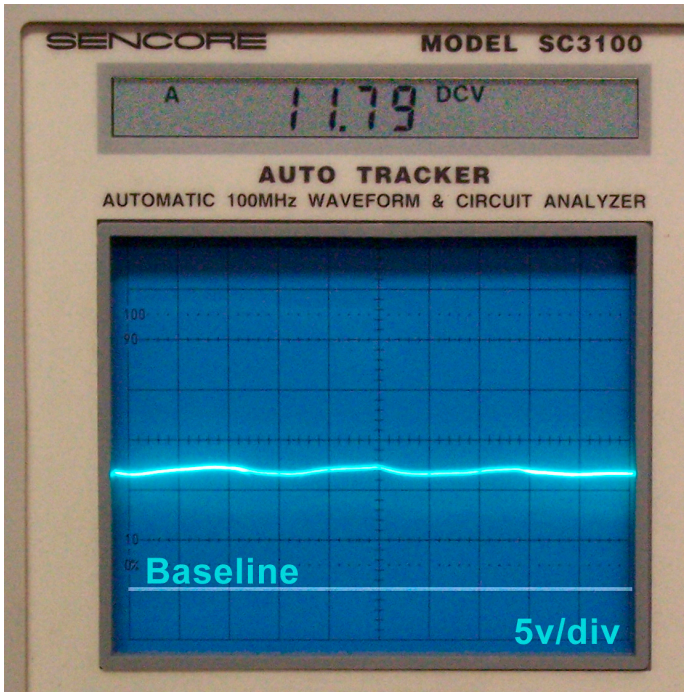


Above: Pin 1 - This are the pulses that come from the TDA9109. These pulses tell the vertical output device when to start and stop generating the "ramp" that drives the vertical deflection coil.

So it really only takes 20 volts to deflect the beam the entire height of the CRT. If you look carefully at the waveform, it is telling you an important story about how vertical deflection moves the beams up and down on the face of the CRT. The key to vertical deflection is to provide a perfectly linear "ramp" so that the spacing of the raster lines is equal across the screen: top, middle and bottom. Poor linearity results in a raster that is distorted in some way. It may be squished at the top or bottom (or both) or exhibit some other undesirable geometric distortion.

Look at the vertical output ramp and notice where the baseline (indicating "ground") falls. It exactly bisects the ramp, doesn't it? That makes perfect sense. When the voltage at the yoke is zero, there is no current flowing and the electron beams in the CRT are pointed straight ahead, at the exact center of the CRT.

As you look at the ramp, you can see that half the time, the voltage is positive (indicated when the ramp is above the baseline). When



Above: Pin 2 - This is the +13 VDC power supply. This comes from the SMPS. You'll notice some ripple at the vertical frequency. This is normal but I was a little suprised to see it, considering the 2200 uf 16 volt electrolytics (C202, C206) that are hanging on the supply lines, close to the IC. By design, these capacitors provide a nice, low impedence source, very close to the load, typically mitigating any ripple.

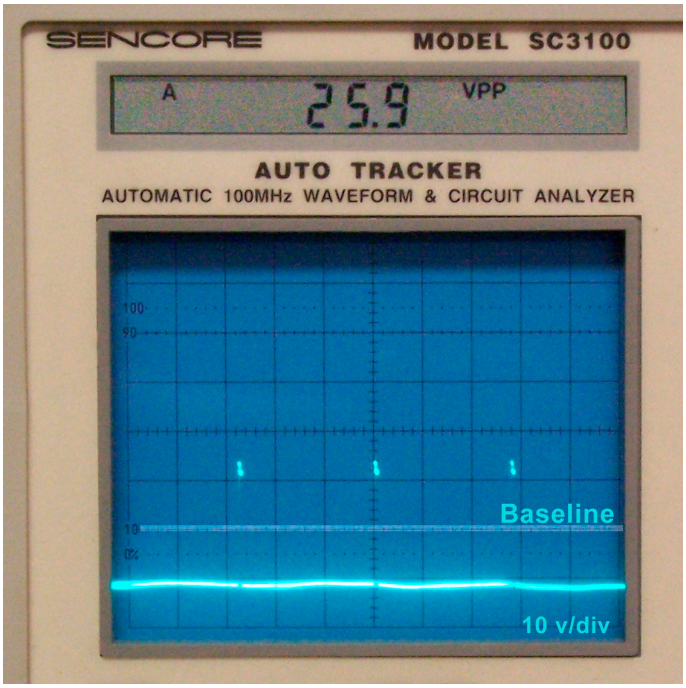
the ramp dips below the baseline, the voltage is negative. Boy, this is making perfect sense, isn't it? Positive voltage moves the beams in the top half of the screen while negative voltage moves the beam in the bottom.

When the ramp is at the top of the sawtooth (around +10 volts), the vertical deflection coils are generating the exact amount of magnetic field required to move the electron beams to the top edge of the CRT. As the vertical output voltage falls in a linear fashion from +10 volts DC to zero, the beams descend from the top to the exact middle of the CRT.

Without pausing or altering its rate of change, the vertical output voltage crosses zero volts and swings into negative territory. As a result, the beams continue to descend until, at -10 volts, the beams are kissing the bottom edge of the screen.

It has taken us a while to get the beams from the top to the bottom of the screen. It might take as long as 16 milliseconds to mosey our way from the top the bottom, completing a single "field." But now we're done drawing the field and we need to zip back up to the top of the screen as soon as possible. This is the vertical retrace and we don't want to mess around here. Since we're not drawing anything on the screen during the vertical retrace (remember, the "blanking" circuit shuts down the electron guns during retrace) we want the magnetic field in the vertical deflection coil to reverse polarity and slam the beams up to the top.

And, if you haven't figured it out by now, that's the purpose of that really tall spike that you see between each cycle of what is an otherwise ordinary sawtooth waveform. That's the vertical retrace. In order to make the vertical retrace happen, we slam the vertical deflection coil with a pulse of around +38 volts. That quickly reverses the yoke polarity, bringing the beams back up to the top of the screen in a timely manner. In other words, speed is of the essence and we are actually



Above: This is pin 4, the flyback generator. Notice the swing from -13 VDC to +13 VDC.

going to "overshoot" it at this point, bringing the magnetic field to the point where the beams would actually be above the top of the screen, if the beams were on (which they are not, due to the blanking circuit that engages during retrace).

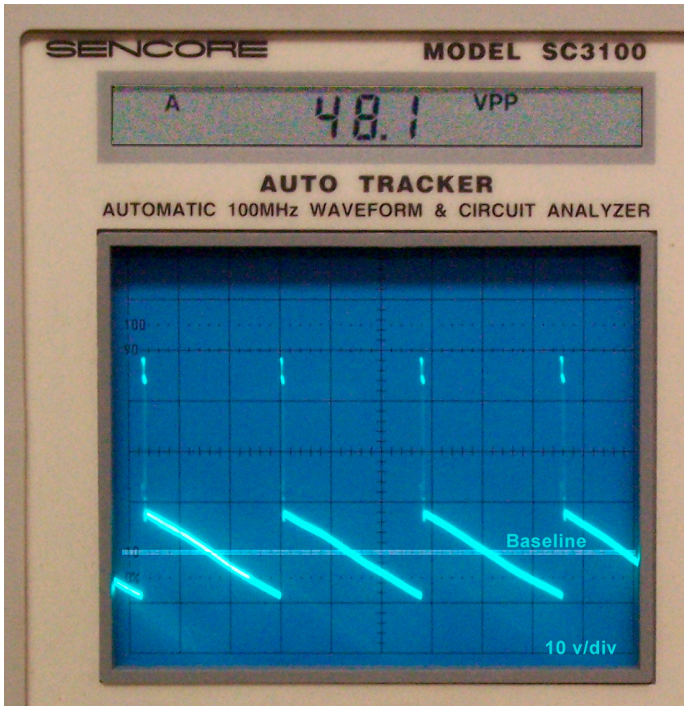
The pulse is short and the voltage is quickly stabilized back at +10 volts. When it's all good, blanking disengages and the video circuits take over, controlling the electron guns for the remainder of the active video time. The process is repeated some 60 or more times per second. This is called the vertical refresh rate. 60 Hz, 72 Hz, 85Hz and higher are some common refresh rates.

So, the big question is this: Where are we going to get the 36-48 V peak-to-peak voltage that we require for the vertical retrace when the vertical output IC uses just a 24 to 26 VDC power supply?

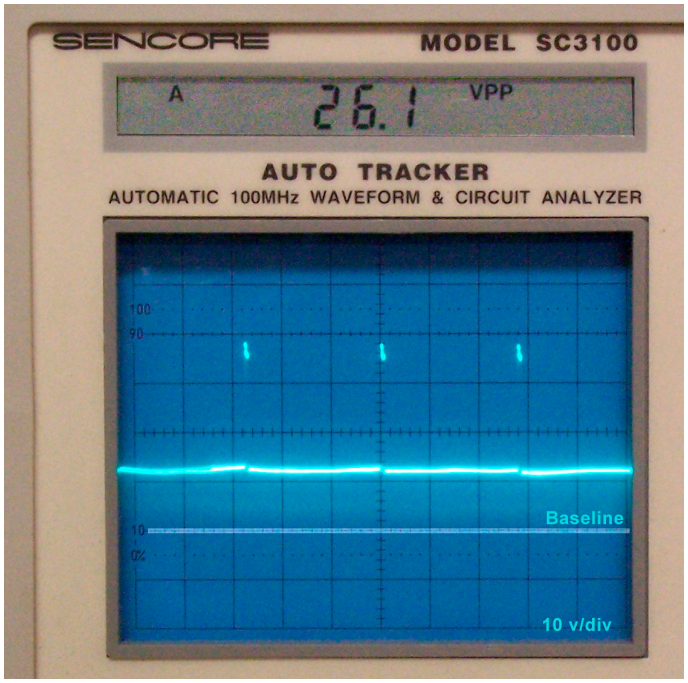
This is the purpose of the "charge pump" or "flyback" circuit. In this case, the charge pump (flyback) capacitor is C203, a 220 uf, 35 volt electrolytic. This is an absolutely typical value that you should have in stock. The negative side of this capacitor is connected to the Flyback Generator output of the KA2142.

Notice that the "ground" pin of IC201 is not connected to ground at all. It is actually connected to the -13 VDC power supply output of the SMPS. This is a very interesting little wrinkle as the vertical output IC is almost always powered by a single-ended, +24 to +26 volt power supply. In this case, the chip gets its power from +13 VDC and -13 VDC. This provides the same actual total supply voltage (a swing of 26 volts) but derived differently. Why? You'll find out later.

During operation, C203 is charged by connecting the negative end to -13 VDC and the positive terminal to +13 VDC. The charged capacitor is now a "source" that is charged at +26 VDC. You can kind of think of it as a battery at this point. With the capacitor fully charged, the negative end of C203 is disconnected from the -13 VDC supply (this is all done internally, inside the IC, of course) and connected to the +13 VDC supply instead. Diode D201 prevents the charged C203 from becoming shorted when the negative terminal is connected to the +13 VDC.



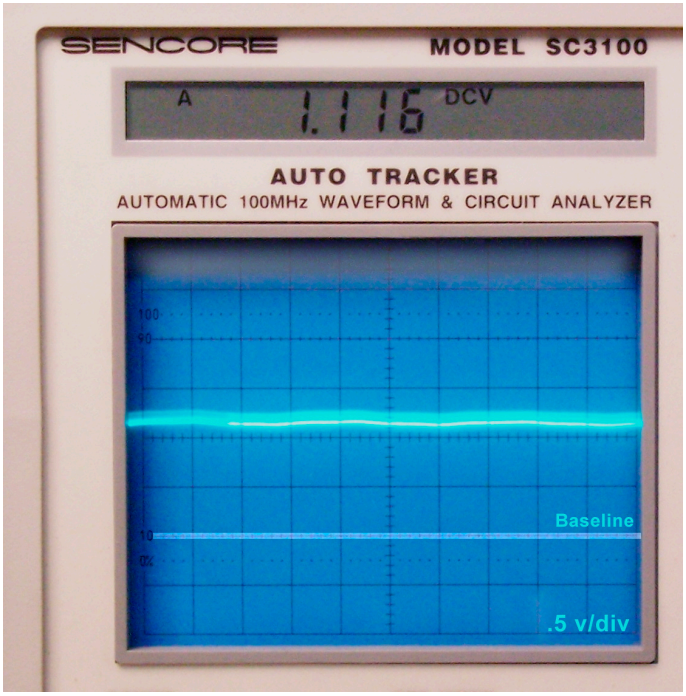
Above: This is what it's all about. This is the vertical output at pin 6. Notice the linear ramp at + and - 10 volts and the giant, vertical retrace spike that quickly forces the beams from the bottom to the top of the screen during the vertical retrace time.



Above: Pin 9. This is the "high" Vcc power input for the vertical output stage, after the flyback (charge pump) circuit has performed its amazing voltage boost.

What we have done here is to charge the capacitor to +26 volts and then put it in series with the +13 VDC power supply for a total of around 40 volts, giving us the voltage we need for our vertical retrace pulse. It's like a +26 volt pulse "riding" on top of our +13 VDC supply voltage. Pretty nifty, huh?

When the charge pump/flyback/boost capacitor fails, many symptoms of vertical weirdness can occur. You can suffer poor deflection (shrunken screen) or you may see vertical retrace lines at the top of the screen as the blanking circuit lets go before the deflection makes it back up to the top. As the boost cap begins to fail over time, the picture shrinks. To compensate, technicians will naturally adjust the height of the screen. As the boost cap gets worse over time, the vertical output IC has to work harder to compensate for the loss of voltage. It does this by pumping more current through the circuit. Eventually, the IC fails.



Above: Pin 10. This is a DC voltage that comes from the V_{REF} (pin 21) output of IC301, the deflection processor. This reference voltage allows the deflection processor (itself under the control of the microprocessor through the I^2C bus) to control vertical geometry.

Here is the important thing: Many techs will replace the bad IC, only to see it fail again in just a few minutes/hours/days/weeks. It is likely that the boost cap is bad and that's what actually caused the IC to fail in the first place. When you replace the IC, always replace the boost cap. Don't bother testing it. Replace it. It's cheap insurance.

The same hold true for the other electrolytic capacitors in the vertical output circuit. As long as you're there with a soldering iron, you might as well change 'em all! However, in the Tovis monitor, there is one electrolytic capacitor that is conspicuous by its absence. It's the AC return capacitor that you normally see in series with the return path of the vertical deflection coil. In most other monitor designs, you will typically see a 2200 uf, 35 volt electrolytic capacitor between the return leg of the deflection coil (the end that's not connected to the vertical output of the IC) and ground. With a single-ended power supply (using just one supply of +24-25 VDC) we need it to block the DC output of the IC so that just AC passes through the yoke. Unfortunately, the capacitor is both a common failure item and a source of poor vertical linearity as all of the yoke current has to pass through it and, as it ages, its characteristics change with time.

Because of Tovis' unique "split supply" operation, the output of the IC is always balanced with zero volts in the middle and we can run this as a true DC amplifier with excellent linearity. The return path of the vertical deflection coil no longer requires a giant electrolytic capacitor in series but rather is connected through a fraction of an ohm resistor, R209 (just .82 ohm) to ground. The small IR drop developed across R209 increases in a linear fashion with the yoke current and is fed back into the inverting input of the KA2142 in order to maintain excellent linearity.

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