February, 2002

Randy Fromm

As this February 2002 issue of Slot Tech Magazine goes to press, TechFest II has just concluded. Once again, it was a sold-out event. What was to have been a one-time technical seminar, has taken on a life of its own and blossomed into something else. I'm not quite sure what that "something else" is but I have had requests to hold a TechFest in Michigan/Wisconsin, the Gulf Region and the Eastern Seaboard. A small handful of vendors has also asked me to consider allowing tabletop displays or booths at the next TechFest. If you have any suggestions in this regard, I'd appreciate a shout from you.

And speaking of shouts, I'd like to give a shout-out and a big Slot Tech Magazine THANK YOU to the following folks who presented at TechFest II: Michael Harris of Coin Mechanisms, Inc., Don Seagle of Asahi Seiko, Mark Roberts and Paul Hatin of 3M Touchsystems, Rich Raley of Mars Electronics, Inc., Jack Geller and Tom Talbot of JCM and Gary Morinville of Sencore. All of these folks did a wonderful job teaching us the ins and outs of Hoppers, Coin Comparators, touch screens, bill validators and test equipment. You can look at the pretty pictures on page 28.

This month's Slot Tech Magazine offers an in-depth look at IDX coin validators. Sample coin? We don't need no stinkin' sample coin! Read about it, starting on page 4.

Conquering noise is the job of the AC line filter. Read all about my first introduction to electrical interference in EMI a Go-Go starting on page 10.

This month, contributing writer and IGT trainer Ken Locke takes a break from hard-core technical writing to bring us a human-interest story about females in gaming. Read Reel Women starting on page 14.

From Ireland, Martin Dempsey gives us the International View starting on page 18. You'll see a lot more from Martin next month as he and I both review the ICE show, held at the end of January, too late to make it into the February issue of Slot Tech Magazine.

The rest of this month's magazine is really on the techie side. Read about the CRT heater in two articles, HK Shorts beginning on page 21 and Open Heaters beginning on page 26. This will be the final contribution from Frank Sutter. He has retired from gaming and has some personal matters that preclude his contributing to Slot Tech Magazine. Thank you, Frank, for all you have done. Anyone who cares to step up to the plate is welcome. Writer's guidelines are posted at the slot-techs.com website.

Finally, part one of a two-part series on switching regulator power supplies begins an illustrated, in-depth look at how switchers work and how to repair them when they don't.

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

Randy Fromm

Randy Fromm's
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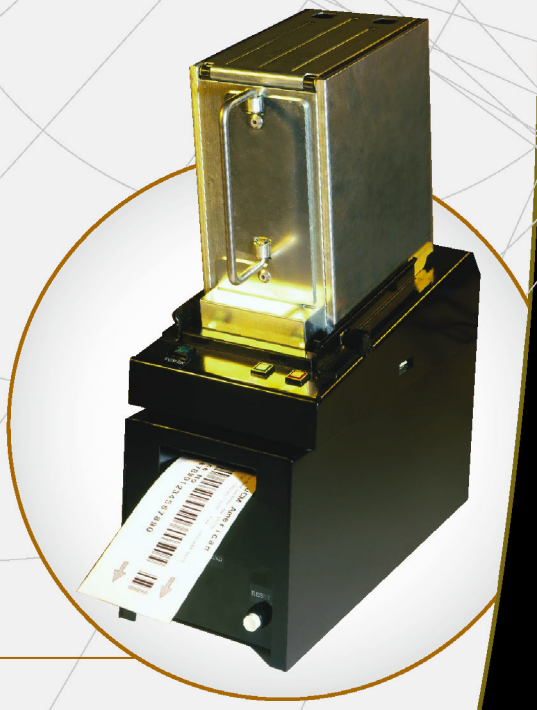

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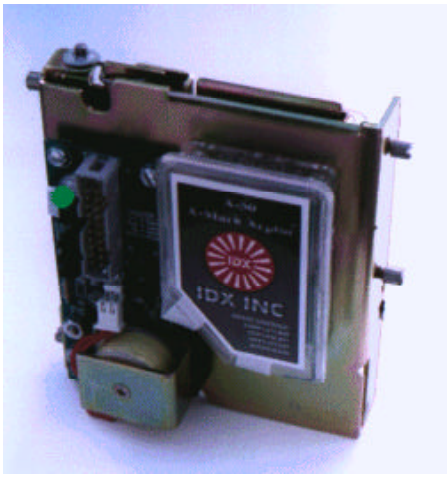
Introducing the IDX

By Kevin Noble



In the ever-growing gaming industry, the technology of slot machines changes like the weather in Michigan. In the last couple of years, the IDX coin comparators have been introduced to the province of Ontario's gaming industry. I was first introduced to the CC series comparators and kind of got used to them but within the last year, we went through a complete overhaul of the entire gaming floor, adding more floor space with the same amount of machines but with all brand new games.

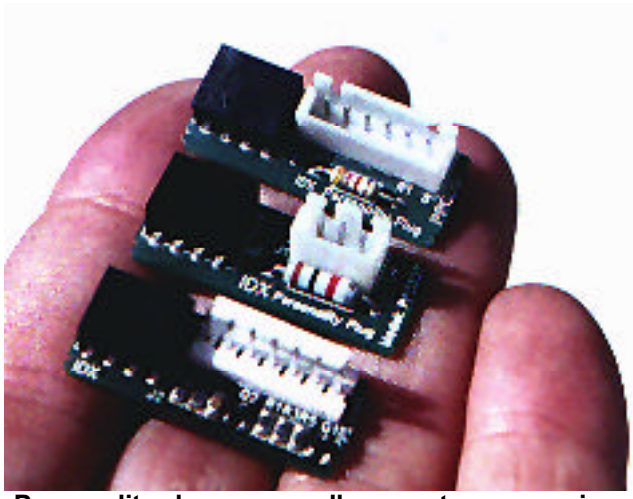
All the new games came to us with the IDX-10 X-Mark Xeptors. Like anything else, we had to get used to the new comparator's programming, diagnostics, field tests, and troubleshooting. At first, because of not knowing much about them, it was your classic swapping to get the game accepting again. During the renovation of the gaming floor, we never had the opportunity or the time to experiment and play with our new toys.

Over time, the IDXs wore in and the troubles now seem to be minimal. When reading the IDX book, we soon find out about the many capabilities the IDX has. You can program the IDX for the coins you want to accept along with programming coins that you don't want it to accept. Program for multiple coins to be accepted up to 6.The IDX itself has the function of its own field tests and tells you the status if it passed or failed. Adjust the thickness of the coin path with a slide adjustment, snap in spacers for the diameter of the coins, view reports on the configuration of the IDX, an X-Key to lock out and eliminate the potential threat of any unwanted personnel to tamper with the programmed coins, an X-Key Management Software to manage and track authorized personnel that when you log on it allows you to place a personal ID and time and date stamp, and last but not least the X-Terminator option that is placed in the top section of the tower light. When a tilt occurs, the light comes on until the tilt times out.

IDX Operation Overview

When in programming mode, the coin acceptor records an electronic image of the metal alloy three times with three different sensors. Ten sensors read diameter to within .015 inch and six sensors look for a code embedded within the coin or token. Coins or tokens subsequently inserted are compared to the electronic image that must match five parameters and are either accepted or rejected.

The IDX acceptor supports multiple coins or tokens. Six separate coins could be programmed to accept six discrete coins or tokens. In addition, the IDX can be programmed for multiple coin-in signals. A good example of this is that in coin one position, it can be programmed as a quarter coin accept (single coin-in signal), while coin position two is programmed as a dollar token accept (four coin-in signals). In this case, the machine accepts quarters and posts one credit to the credit meter for each coin accepted at the same time the machine could also ac-



Personality plugs are small connector conversion modules about as big as the last segment of your little finger

cept one-dollar tokens and post four credits to the credit meter for every dollar token accepted.

Another feature the IDX is capable of performing is called the unwanted shadow coin. This allows you to teach the acceptors the electronic image of an unwanted shadow coin in order to eliminate false acceptance of troublesome coins, tokens, or slugs. Coins possessing the X-mark feature, the IDX has the ability to measure and then differentiate between coins through optical diameter measurements, edge and the center of a coins metallic alloy composition, and the X-mark that is minted on the surface of the coins.

The Parts

Personality Plugs

The personality plugs are used to convert existing coin-in harness connections without having to do any rewiring on the game. The personality plug has its own type for each of the Coin Mechanisms CC-series and the IC-series, and for each manufacturer.

Sliding Adjustment

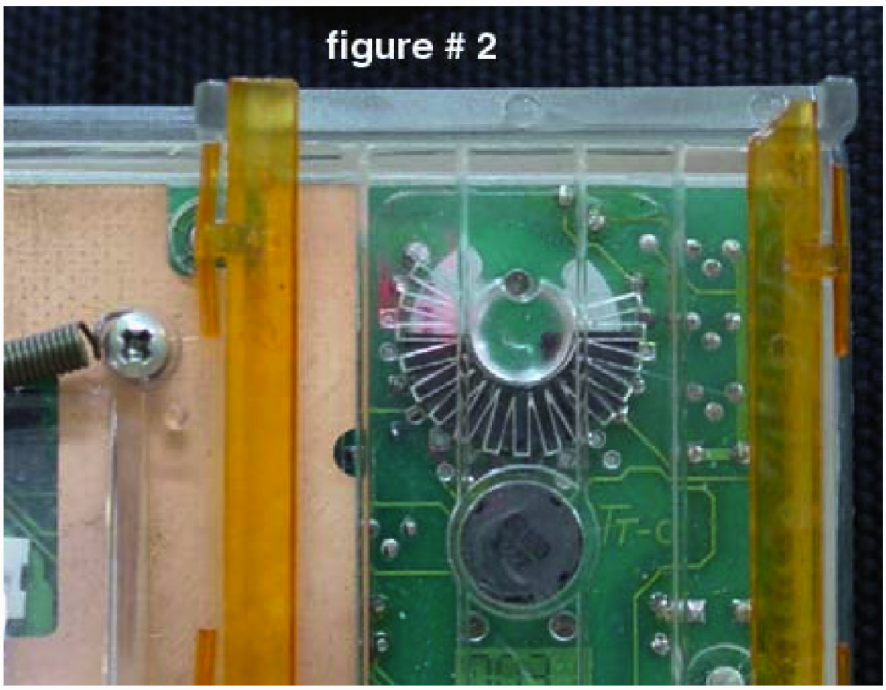
The slide adjustment allows you to slide a tab to a different thickness of a coin in case the IDX needs to be programmed to a different denomination or coin thickness. There are eight different holes the sliding tabs can adjust to, as thick as .130" to a slimmer thickness of .087". We would want to set the adjustment of the tab for.010" to .020" more than the intended coin thickness.

Snap-In Spacers

The snap-in spacers are used to center the coins being accepted over an optical and inductive sensor. These spacer widths can range from 0.062" to 0.300". These spacers could be glued in with a small dab of silicone to prevent the spacer from moving or accidentally falling off during game play. Ideally we would want about .025" to maximum of .075" gap between the coins width and the wall of the spacer. This allows for the alignment for the center of the coin for better diameter measurement, edge and coin metal alloy measurements, and the X-mark measurements. Figure #2 shows the removable snap-in spacers that are interchangeable when a denomination change is needed. Please notice the shaved spacer on the right side, which helps with a smooth acceptance.

X-Key (Security Key)

The X-key we like to refer to be the black box. This is a small black box with a 3-pin harness that plugs into the IDX, which allows us access



to reprogram a certain denomination of coin or token to be accepted by the IDX. Without this X-key, the IDX will lock out any untrained personnel from changing any of the learned coin characteristics.

X-Key Management Software

This is a Windows based software utility for managing and tracking any X-key activity. This allows authorized personnel to communicate with the IDX. The personnel involved in this process will have their ID, the time and date stored in a file system on the PC and in the IDX.

X-Terminator Option

This is a 5-red LED board that is mounted inside the top section of the tower light on top of the slot machine. This allows for the detection of IDX tilts such as slow or reversed coins, excessive coin rejections, and blocked or dysfunctional IDX sensors.

Diagnostics

With the machine power on and the IDX enabled, slide the IDX coin acceptor front cover up. Locate the red push button and the rotary switch near the bottom of the printed circuit board. Verify the rotary switch is in the "0" position (this is normal operation) and that the LED is illuminated green. If the LED is illuminated yellow or is alternating between green and red, perform the test to determine if there is a malfunction.

Gate Relay Test (0)

Verify the rotary switch is set to the "0" position. Press the push button. Verify the gate relay activated and that the gate freely moves.

Inductive metal Sensor (E, F)

Turn the rotary switch to positions "E" and "F" to test the inductive sensor. A green LED indicates normal operation. A red LED indicates either that there is metal in front of the sensor or that the circuit has failed. Remove the metal or replace the IDX.

Diameter Optic Sensors (B, C, D)

Turn the rotary switch to positions "B", "C", and "D" to test the diameter optic sensors. A green LED indicates normal operation while a red LED or orange LED indicates that there is a blocked sensor or that the circuit has failed. Clean the optic or replace the IDX.

X-Mark Sensor Calibration (9, A)

Place a twice-folded piece of white paper into the center of the coin chute. Turn the rotary switch to position "9" (front optics). The IDX will self-calibrate the sensitivity of the reflective sensors. The LED illuminates orange after calibration. Repeat for position "A" for the rear optics.

Memory Test (7)

Turn the rotary switch to position "7" to test for valid coin "LEARN" memory. A green light LED indicates valid memory information. A red LED indicates corrupt memory information. Reprogram coin-in function. Replace the memory EEPROM and reprogram.

Credit Sensor Test (8)

Turn the rotary switch to position "8" to test the credit sensors. If not installed, the LED will blink yellow. If installed and in good order it will be green. If it is installed and dirty or blocked, an orange to red color

Clear Coin Path

The coin path is accessible without removing the IDX from its mounting bracket. Gently grasp the IDX plastic cover and rotate the unit to the right. Dislodge the coin jam. Verify the coin path door is fully seated when closed.

IDX Set-Up Procedure

1. ADJUST DEPTH GUIDE (SIDE RAIL) FOR DESIRED THICKNESS.
2. REMOVE PERSONALITY PLUG, AND PLUG IN X-KEY
3. PLUG PERSONALITY PLUG BACK IN.

TURN POT TO CHANNEL #2.
PRESS BUTTON 1 TIME.
INSERT 6 COINS TO PROGRAM.
TURN POT BACK TO NORMAL POSITION.
REPEAT FOR CHANNELS #3, AND #4 TO PROGRAM UNWANTED COIN IN CHANNEL #1
TURN POT TO POSITION #1
PRESS BUTTON 13 TIMES
INSERT 6 UNWANTED SAME COINS.
TURN POT TO NORMAL POSITION.
REMOVE PERSONALITY AND X-KEY.
PLUG PERSONALITY PLUG BACK IN

4. TEST BOTH GOOD COIN AND UNWANTED COIN.
5. IF ACCEPTANCE IS POOR, PERFORM CALIBRATION PROCEDURE.

Calibration Procedures

1. TURN SWITCH TO POSITION #9
2. INSERT WHITE PAPER INTO THE OPTICS PATH. (THE PAPER MUST BE THE WIDTH OF THE COIN PATH AND THICK ENOUGH TO PUSH AGAINST THE FRONT AND BACK OF THE COIN CHUTE).
3. PUSH THE BUTTON NEXT TO THE SWITCH, ONE TIME.
4. THE LED WILL FLASH RED AND GREEN, AND TURN TO ORANGE.
5. WITH THE PAPER STILL INSERTED, TURN THE SWITCH TO "A" AND PUSH THE BUTTON AGAIN.
6. AFTER CALIBRATION, ERASE ALL CHANNELS AND REPROGRAM.
7. REPEAT STEPS ABOVE.

Erasing Programmed Channels

X-KEY MUST BE PLUGGED IN

1. TURN TO POSITION #1
2. PUSH BUTTON ONCE
3. TURN TO POSITION #2, AND PRESS THE BUTTON AGAIN.
4. REPEAT PROCEDURE FOR POSITION 1 TO 6.

Troubleshooting

Problem: Not accepting coins Solution: Adjustment thickness tab has moved from original programmed location. EEPROM bad, needed replacing Lost program, needs reprogramming Ribbon cable unplugged Door not fully seated or bent pivot arms. Coin in harness wires pinched by IDX cover Wrong personality plug Tilt time set too high, IDX has not yet reset Rotary switch not returned to home position X-mark doesn't match Coins passing too slow The bad-coin counter reached its limit of 8 Failure on edge metal IDX inhibited Diameter was read incorrect Accepted coin, reversed direction detected

Problem: Poor acceptance Solution: Wrong snap-in spacers, coins not centered Spacer missing Optics are dirty and needed cleaning Adjustment tab not tightly secured in hole

Problem: Coin-In Jams Solution: Wrong size tokens Snap-in diameter spacer out of position causing jam Paper found in coin path Gate assembly screw is loose

Problem: IDX will not hold program Solution: Bad EEPROM

Problem: Sigma Reels Only-opening and closing the IDX door causes the game to go into a coin in tilt, after resetting the tilt, the game gives credits.
Solution: On dipswitch #1, dip #1 was set to mechanical comparator

NOTES: The internal sequence for the IDX to check is: 1. The diameter 2. The token code 3. The edge metal "S" 4. The edge metal "A" 5. The center metal 6. The memory

ODDS AND ENDS

Recommended Glue

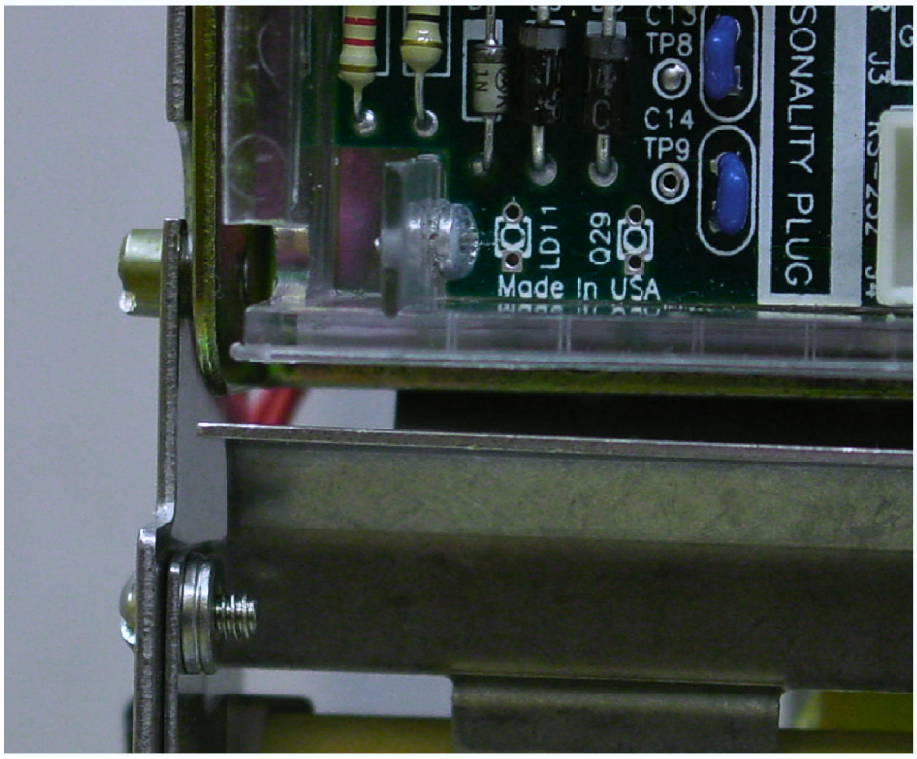
IDX is recommending that the use of Scotch Grip #4475 glue to prevent permanent welding of the plastics. Scotch Grip #4475 will still allow you to pop the snap-in spacer out with minimal damage to the housing. A little scratching of any left over glue with an Exacto knife allows for replacement of a different snap-in spacer.

The Modification

Do you ever have a problem with the IDX that when it is programmed, it accepts just fine but soon as you replace the cover, the IDX it does not accept any coins. This problem is caused when the front cover is rubbing on capacitor C6. If the cover rubs on the capacitor, the board flexes, causing the coin learned readings to be much lower than they should be. There is a simple fix for this problem. By inserting a small screw in the bottom left hand corner of the acceptor, it is held down enough to keep the front cover from rubbing on C6.

The R-10 Replaceable Resistor

The resistor is known as a fusible resistor and is used to protect the IDX board from harmful voltages that could destroy the board. The most common problem of R-10 blowing is the misconnection of the personality plug. On the newer version of the IDXs, the capacitor is now mounted in front of the personality plug to prevent accidental misconnection.



Self-Updating of Memory

The IDX also comes with a self-updating of the memory for each channel programmed for every 68 coins that are inserted and accepted to each memory position.

Programming the IDX

Viewing the contents of your IDX, we can access this by going into the HyperTerminal program on your computer. This allows us to view such things as our token code, metal values, and diameter values, and at the same time allows us to set different values such as the tilt time. To view these new figures, we must first turn "CAPS LOCK" on. Type HH and the message "HUMANLY HEXADECIMAL" should appear. Type "R." This allows a report to be written about the IDX memory.

Tilt Time

The amount of time the IDX will time out if 4 coins inserted are bad in a row. (Bad coin count reaching 8). Type "P20000000" tilt time is set to 0 seconds Type "P20000003" tilt time is set now to 1 seconds. (Program in 1/3-second increments) Type "S" to save the new value

Testing the IDX

After setting and programming your IDX, we now have the luxury of running coins through the IDX and actually seeing the figures the IDX has generated from the coins running through. The computer will display the following numbers in this sequence: 2 ID22IF1800. The first column represents the coin prop-

erties most closely matched to the channel # Second, third, and fourth columns represent the three metallic properties the IDX made when the coins passed through it. (E-metal S, E-metal A, and C-metal A). The fifth column represents the diameter of the coin measured (reading between 15 & ID are normal)

First Column Codes

2 = second channel 3 = third channel 4 = fourth channel U = first channel programmed of unwanted coin B = bad coins inserted D = diameter does not match M = metal sense failure

With the ever-growing expansion of gaming technology today, IDX has been slowly replacing some of the older CC series of coin mechs in casinos all over the world. They are very easy to program and repair. The parts are technician-friendly and the company is taking every complaint seriously and upgrading their product. This has allowed us to troubleshoot, and re-program on the floor to minimize downtime.

The IDXs have limited the games from accepting any foreign tokens at all. They deter stringers and slot cheats from trying to take advantage of your assets.

I am not an engineer or an expert, nor am I affiliated with the IDX Corporation. This is my opinion that I have formed from experience with Coin Comparators and with IDX. They both have their good points and other casinos, technicians, and managers can decide for themselves, which coin acceptor they prefer. I have tried to shed light on what we are currently using, at the same time trying to help fellow technicians complete their tasks accurately and easily.

When referencing the material to put together an accurate article for technicians who are interested in the new technology, Tina Rogers from IDX was a great help in forwarding me a lot of information regarding some of IDX problems that I could pass on to you. I would like to thank the technicians at Windsor Racetrack Slots and Tina Rogers for taking an interest in helping others using the IDX to report accurate information for every one to reference.

- Kevin Noble
knoble@slot-techs.com

Are you a slot tech with something to share? Join the best technical writers in the gaming industry by contributing to Slot Tech Magazine. Visit the website at slot-techs.com for writer's guidelines.

EMI a Go-Go

By Randy Fromm

I wasn't born into the gaming industry. Before entering this industry, I was in the music business. I was a musician (still am, to some degree). I was a roadie and I was a sound engineer for live concerts. I was the guy that set the microphones for the performers and did the live mix for the sound augmentation.

It was 1971 and I was working as the assistant soundman at the Whiskey a Go Go on Sunset Boulevard in Hollywood. Yep! Those were the glory days with flower children roaming the street and hippies of all sorts flogging copies of the Los Angeles Free Press to anyone and everyone that was walking or cruising (at more-or-less the same speed) down the world-famous "Sunset Strip."

At that time, The Whiskey played host to many of the famous bands of the era. I was fortunate to work with some well-known acts such as America, ZZ Top, Patty LaBelle and many others.

All of these folks were great to work with but for me, the crowning glory was an opportunity to work with The Legend, BB King. BB King was actually coming to The Whiskey. Donnie, the head sound guy, was away on vacation and I was responsible for the sound that night. No problem. This was gonna be an easy one.

"How many vocal mics will you require?" I asked BB's road manager.

"Just one." he replied. "No backup singers this time."

The stage at the Whiskey was almost too small to accommodate them anyway. "Straight stand or boom stand?" I asked.

"Boom stand." He replied.

I had figured on that anyway and already had one ready to go. You'd sure hate to see Lucille smashed against the mic stand, especially YOUR mic stand.

I set a Shure SM57 microphone on the stand and plugged it into the snake, the long cable that carries the mic inputs from the stage up to the mixing console that was strategically placed in the middle of the room, on a tiny platform welded to the outside of the stairway that lead from the main floor to the balcony.

From there, the mixed audio was passed to a bank of Crown DC300 power amplifiers and from the amplifiers to the huge JBL speakers and horns that were placed around the club. It's an important technical note that in a system like this, the power amplifiers themselves are pretty much always running at full gain. The input level is adjusted in order to control the volume, not the gain of the output amplifier.

Figure 1

"How about the drum kit?" I asked the road manager.

"Just the usual." he replied, meaning just three microphones were required: one for the snare, one for the kick and an overhead to catch the cymbals. I used an SM57 for the kick, an SM58 for the snare (its integral, wire mesh windscreen serves to protect the microphone should the drummer wack it with a drumstick) and an AKG condenser microphone (maybe a C1000, I really can't recall) for the overhead as it responds well to the high frequencies of the cymbals. As I recall, I added a fourth microphone to catch the Hi-Hat because, well, I LIKE the sound of the Hi-Hat.

I added some others for the guitar and bass amplifiers and the top and bottom of the Leslie speaker for the Hammond B3 organ and I was

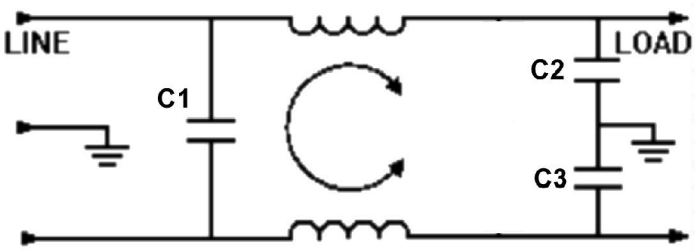


Figure 2

good to go.

Or so I thought. You see, despite all of the big names that had appeared there in the past, the Whiskey was still just a nightclub. There was a small, glassed-in booth at the end of the entry vestibule and if Albert the doorman deemed you worthy to enter, you simply paid your money (in cash, of course) to the girl behind the glass and entered the club.

But not this time. This was BB King and for reasons unknown to me, Mario Magliere, the club's manager, had decided that we needed to sell tickets. I'm not talking about simply handing out a ticket to everyone that passed into the club. Mario had had an actual ticket machine installed in the booth.

Those of you who are over 40 years old probably remember these ticket dispensers. You saw them in action every time you went to the movies. A far cry from the small, efficient ticket dispenser that we know today, this was a fairly large device that lived under a flat, stainless steel panel that became the actual countertop in the ticket booth. When the ticket seller pressed a button, the dispenser made a series of loud clunking noises and VIOLA! The ticket appeared as if by magic, having been dispensed through a small metal flap in the stainless steel panel. Amazing technology.

The sound check had been scheduled for 3:00 PM as usual. The stage was set and I was eagerly awaiting my chance to meet BB King. Everything was cool when he walked down from the dressing-room area onto the stage. Everything was cool when I introduced myself to him. Everything was cool as I gave him instructions about the hand signals we used at the Whiskey in order to tell me if he needed the vocal monitor speakers turned up or down. Everything was cool when I showed him to his mark on the stage.

Everything was most definitely NOT cool when we started the sound check. As the first song began and I was tweaking the levels and EQ at the mixing board, Mario was, unbeknownst to me, proudly showing off the new ticket dispenser to Elmer Valentine, the owner of the club.

When Mario pressed the button to dispense a ticket, the most unbelievably loud noise issued forth from the sound system. It sounded, more-or-less, like a dump truck full of riprap dropping its load on the dance floor. It just has to have been over 120 dB of the most ungodly cacophony of noise that you've ever heard.

I freaked out! What the hell was that? I knew that I had never heard anything like that before but I also knew that it was coming from MY sound system. In a flash, I reached out with my right hand and flicked down the master sliders that controlled the mixer's output level. Down on stage, everything had come to a screeching (and I do mean screeching) halt.

"What the <expletive deleted> was that?" asked the road manager.

"No idea. Gimme a sec" was my appropriately lame response. I was now looking right into the eyes of BB King while he's looking right back at me with the little finger of his right hand wiggling back and forth in his ear.

A few seconds later, another burst of audio hellfire issues forth from the JBLs and I leap from the mixing console, hop over the railing of the stairs and dash over to the DC300s to kill the power.

Now the telephone at the mixer is ringing. It's Mario and he's not happy. No sir, he's not happy at all.

"What the <expletive deleted> is going on? When I use the ticket machine, it makes all that noise on the PA." (He in-

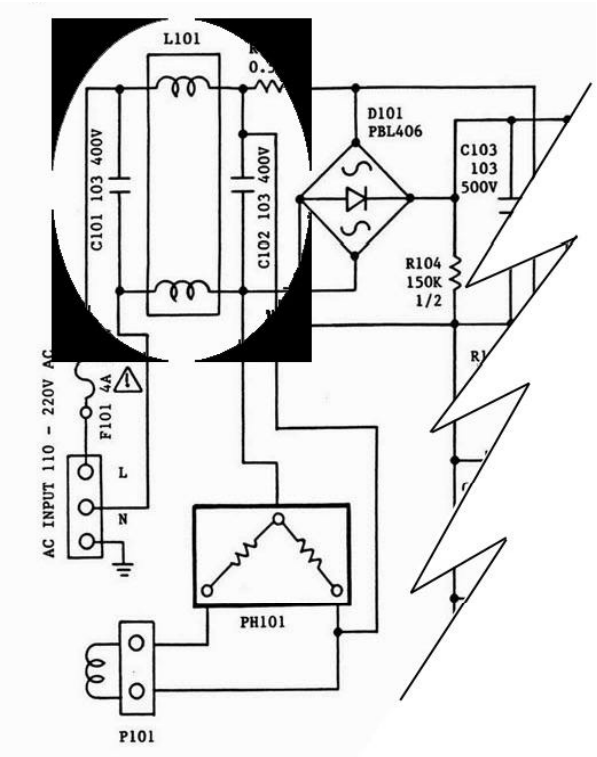


Figure 3. The line filter from a typical monitor SMPS

sisted that it was a "Public Address" system.)

Now, at least, I knew what was going on. There was nothing wrong with my sound system. The horrible noise was being generated by the relay and motor contacts in the ticket machine and entering the sound system as electromagnetic interference or EMI. The EMI was bypassing the preamplifiers in the mixing console completely and was feeding right into the DC300 power amplifiers through the AC power line. No wonder it was so loud.

I asked Mario to hold off on demonstrating the ticket machine until after the sound check and that I would deal with it later. The rest of the sound check (half a song, as I recall. This guy doesn't need a whole lot of rehearsal) went off without a hitch.

Well, that's my BB King story and it's a very long introduction to the problem of EMI and how we address the problem through the use of line filters.

Line Filters

In this context, the word "line" refers to the 120 volt AC power line (or in other parts of the world, the 240 VAC "mains"). Naturally, the AC power is supposed to be a perfect sine wave. That's what's coming out of the power generators (alternators, actually) and that's what everything that is powered by the AC is looking for.

But in the real world, there are lots of things that can dump noise onto the AC power line. In the above example, it was a combination of sparking relay contacts and an arcing motor runout switch that created the EMI. Other sources include AC powered drills, hair dryers, Mixmasters, motors, compressors and a host of other AC powered devices. In some cases, the source of EMI may surprise you. Modern monitors and power supplies would be huge generators of EMI if careful engineering steps were not taken to prevent it.

A line filter is a device or circuit that is designed to remove EMI. Typically, a line filter is a combination of coils and capacitors. These components form a tuned circuit that is designed to pass the 50 Hz or 60 Hz AC power but reject all other frequencies.

Catch It Before It Enters

Most of the time, line filters are incorporated at the AC input of a unit. Most television sets, AC powered radios, VCRs and the like are built this way. In videogames and pinball machines, you often will find an AC line filter that looks something like the one shown in figure 1. Generally, you'll find a small metal box that's soldered together. That complete enclosure is important. You'll always find that the metal case is connected to the Earth ground of the power plug. For this reason (among others), it is important that the ground pin of the AC power plug is never defeated.

Inside the box, you'll likely find a circuit like the one shown in figure 2 (not that you'll actually open one up to see what's inside. You won't.). The combination of coils and capacitors forms the filter circuit that passes the low-frequency AC but blocks the high-frequency EMI, preventing it from reaching the electronics.

In a nutshell, the AC line filter takes advantage of the fact that both coils and capacitors are frequency dependant components. That is to say, their characteristics change depending on the frequency of the AC that they see. The most obvious characteristic change is in the component's impedance. Impedance is sort of like resistance. It is the opposition to current flow. Like resistance, impedance is measured in ohms. The difference is simple to understand. Resistance refers to DC resistance. Impedance refers to the component's opposition to flow when AC is passed through the device.

Coils, for example, have an AC impedance that is directly proportional to the frequency. At 0 Hz (DC) coils have a very low resistance. The higher the frequency of the AC, the higher the impedance will be.

Capacitors behave in the exact opposite manner. A capacitor's impedance is inversely proportional to frequency. Capacitors block DC completely (infinite impedance) but allow AC to pass through. The higher the frequency, the easier it is for the AC to pass.

With that in mind, take a look again at the circuit in figure 2. Notice that the AC passes through the coils as it makes its way from the input to the output of the line filter. The coils are big enough to pass the relatively low frequency AC power straight through but present a high impedance to the high-frequency EMI, effectively choking off the EMI. In

fact, when a coil is used in this fashion, it is often referred to as a choke since it chokes off the high frequencies.

Now take a look at the way the capacitors C2 and C3 are connected. Notice that they're connected between both the hot side and ground and between the neutral side and ground. Since capacitors present a low impedance to the high-frequency AC of the EMI, the interference is effectively shorted to ground without affecting the low-frequency AC power.

Notice too that the capacitors are connected in a couple of different ways. Capacitor C1 is connected directly across the AC power between hot and neutral. Again, this serves to "short out" the high-frequency EMI while being more-or-less invisible to the low-frequency AC.

Catch It Before It Leaves

The same technique can be applied to the thingy that's creating the noise as well. Line filters are SOP for anything that's powered by a switched-mode power supply. An SMPS generates huge amounts of EMI as part of the normal switching action of the transistor(s) in the power supply. Nothing wrong. That's just the way it works.

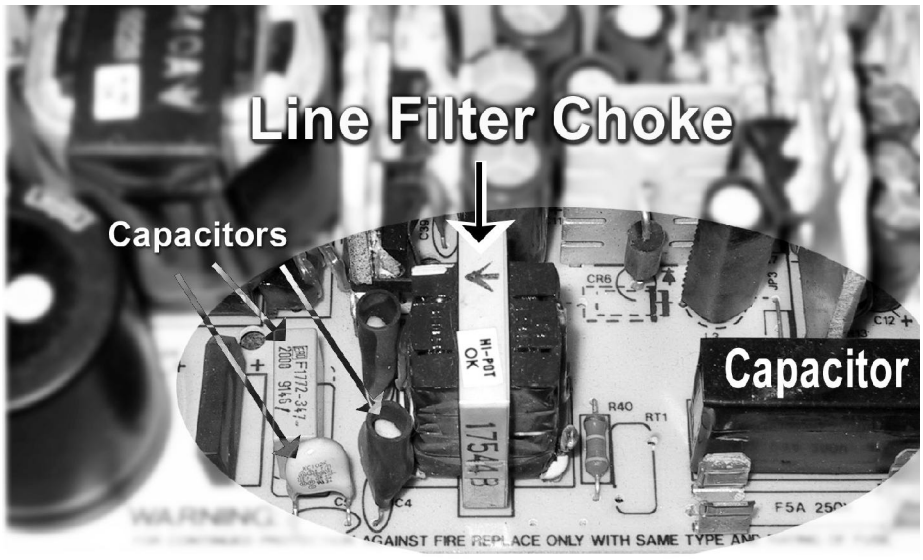
Figure 3 shows a typical SMPS from a monitor. Notice the line filter circuit at the AC input of the monitor? In this case, the filter's there, not to remove EMI as it enters the monitor but to prevent it from getting out of the monitor's SMPS and affecting anything else that shares the same AC power line.

This is how I remedied the problem at the Whiskey. I simply hung a capacitor across each of the contacts and another one across the AC power line.

Naturally, the capacitors in the AC line filter cannot be polarized electrolytic capacitors. This is alternating current and AC will blow up polarized electrolytics as surely as the day is long. Typically, these capacitors are polystyrene capacitors. Polystyrene capacitors are pretty easy to identify once you know what they look like. Figure 4 shows some typical polystyrene capacitors. They can be somewhat cubical but many look like a piece of Chiclets chewing gum. They come in a variety of flavors as well. You can find blue ones, green ones, red ones and brown ones (coffee flavored, I guess). The yellow ones are typically housed in the cubic package.

Line Filter Failures

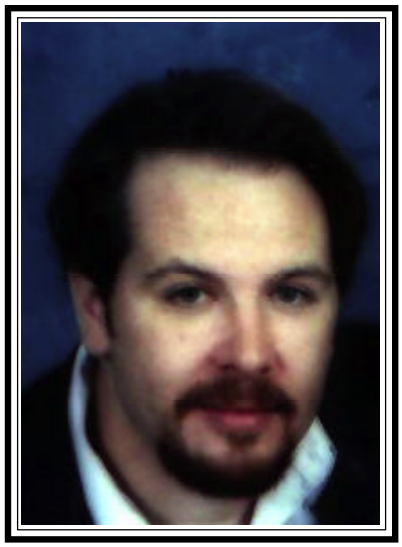
You knew there had to be some sort of repair information in here somewhere, didn't you? Well fortunately, line filters rarely fail. The few I have seen fall into just two categories: The coils open-circuit (usually due to vibration breaking a wire at the point it is soldered to a terminal or to the PCB) or the capacitor short-circuits. This is one of those fairly rare occurrences where you might see a shorted capacitor. It is rare to find a shorted electrolytic capacitor but it does happen to polystyrene capacitors. Experienced monitor technicians are familiar with this type of capacitor shorting in the retrace tuning or s-shaping capacitors of monitors. These are both polystyrene capacitors.



Here is the line filter section of a typical switching power supply

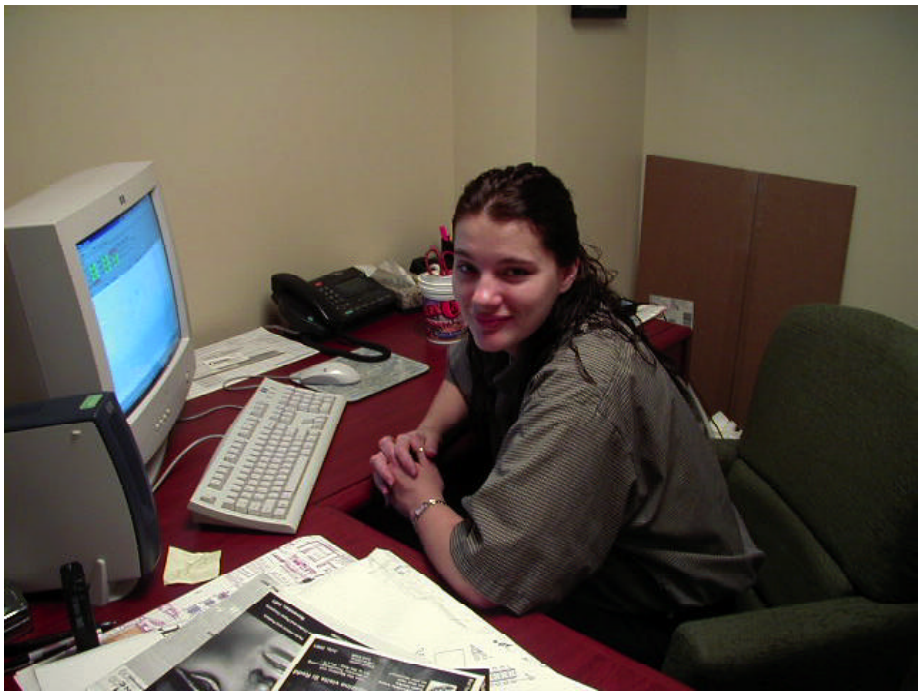
Reel Women

By Ken Locke



It's 4:30 a.m. on the third day of opening at the new est Station's property, Green Valley Ranch. The tech shop is nothing short of a disaster area. The epicenter of gaming technology has become a junk drawer. Glass, boxes of spare parts, new tools and odds and ends of every kind are stacked precariously chest high, and amidst the chaos, droopy-eyed technicians clutch fresh red-eyes from the employee dining room. One of these technicians is not like the others. But she's no odd-man-out.

Holly Brown is one of many female technicians that now grace the floors of the world's casinos. Look out boys, she knows her stuff and has gained the respect of Station Casinos and her fellow techs alike. At age 24, she has solid background in electronics and gaming experience. A graduate of DeVry with an AA in electronics and a proven reputation on machines, Holly and women like her have emerged to stand beside and sometimes ahead of male techs.



Holly Brown of Station Casinos

Officially titled a Gaming System Technician, Holly has risen a bit above coin jams and busted knuckles to maintaining player tracking systems.

"Learn all you can. Expect to get dirty. Expect to sweat."

Enrolling, monitoring and general upkeep of the Acres host system and progressive controller systems has turned into a full time position. In addition to keeping 2500 PTs humming, over 80% of GVR's slots are Ticket-In/Ticket-Out EZ Pay. This is yet another wire poking out of a machine. Throw in fifty or so Clerk Validation Terminals, twenty plus Cashier Workstations and thirty roaming hand-held cashier devices for more then one hundred ambassadors and she definitely has her hands full. In about six months, if she survives, she should have her big blue suit and red cape.

On top of all that, she still does not excuse herself from the backbreaking machine moves that go with the job. Her advice to potential female gaming technicians: "Learn all you can. Expect to get dirty. Expect to sweat."

Meanwhile, one thousand,

Over 80% of GVR's slots are Ticket-In/Ticket-Out EZ Pay

one hundred fifty-four miles away at Tulalip (pronounced too-lay-lip) Casino in northwestern Washington, the future unfolds. This 850-machine floor is home to technicians Lena Fryberg, Dusti Ferron and Cindy Mark. What makes this property unique is that it's maintained almost exclusively by female slot techs. I first met them last year when they attended one of my 960 training classes. And, since to know me is to dig me, they agreed to do a telephone interview.

STM: on speakerphone. Hello Angels (I've always wanted to say that).

All: Hey, how you doin'? How've you been?

STM: I'm good. Hey I am recording this just to let you know. So if you want to talk dirty, let me know I will turn it off.

Dusti: Evil laughter. You better turn it off now then.

STM: Ah. You know what, this is Slot Tech Magazine. We're very edgy. We can say whatever we want. We can even swear if we want to.

Lena: Oh shit. Right on.

STM: What do you call yourselves? Tech Chicks? Slot Babes?

Dusti: They put a sign over our machine cage that said Slut Service. A light bulb was out on the "O", so we had to reorder it. When they finally got it fixed, it was still broken and all it said was "Slut S"

STM: Are you guys are all female by fate or do you purposely discriminate against the Y chromosome?

Dusti: Actually, we just hired some in the past three months.

Lena: All men.

Dusti: They've realized we're not ordinary women. We give them a fair warning when they start. 'We speak our minds and yes, you will get used to it, and if we offend

Girls Rule!! Dusti Ferron, Malia Sterling, Cindy Mark, Lena Fryberg and Maureen Young of Tulalip Casino (from top to bottom)

you I am sorry. There's the door. Use it.'

STM: Wow! Isn't that usually the speech they would give you?

Dusti: Like I said, we're not ordinary women.

STM: So, what kind of challenges do you face that men do not have?

Lena: The discrimination. The thinking of "let us do it for you" or that we're incapable.

STM: And what do you do to prove them wrong?

Cindy: We do it anyway.

STM: Are slots difficult to work on?

In unison. No.

STM: Tell me about life on your gaming floor.

Lena: We have two different types of machines. Our IGT machines are more hardware [issues], whereas our Multi Media machines are more of a networking machine.

STM: Multi Media?

Dusti: They're like PCs on the network with slot games on them.

STM: And, IGTs are more mechanical?

All: Yeah.

STM: So, why so many females at Tulalip?

Dusti: They really didn't have anybody that was trained. So, we were originally attendants and supervisors. And so they asked who was interested. It was already a female dominant department because we were originally doing pull-tabs and mostly women worked in that. It kind of just migrated from a small department to a big department and there were really no men in here.

STM: What did you do to train to work on slots?

Lena: We pretty much had all in-house training on these. We have had couple of the vendors come out with their technicians to give us some quick pointers. But other than that, we do what can and what we screw up, they come out and they fix and we don't look so bad.

STM: Ah, same as men then. Do you do any board level stuff?

Dusti: We just got our new soldering station but they haven't let us work on our own boards.

Lena: I think they are afraid we're going to burn the place down.

STM: Well, you're just girls after all.

Moans of disgust.

STM: Any pearls of wisdom for future lady slot techs?

Dusti: I think for other females who want to be slot techs, I think you should really do it because you really get a lot from it. You do deal with the discrimination but I did put my crew in check and they have realized just how strong I am and that I can do anything they can do.

Cindy: Just this morning there were five of us [doing machine moves], three were guys and only one of them helped. Lena and I did the rest of the work

STM: That sounds about right. So don't you make the new guys do all the really nasty stuff?

Dusti: Depends on what it is. We don't want them messing up too much, because we'll have to go back and do the work.

STM: So your slot shop is covered with, like doilies and potpourri and stuffed animals, right?

Lena: [giggles] No, not at all. It's a mess, glass and monitors all over.

"... they have realized just how strong I am and that I can do anything they can do."

A radio call from the floor suddenly interrupts the flow

of this hard-hitting interview. A new male slot tech voices his concern that a Texas Tea has been booting up for over two minutes. With maternal serenity, Dusti reassures the lad that this condition is normal and to just wait a few moments and "everything will be all right." He never called back. Typical man.

STM: Do you work with any player tracker systems? You know, linking machines with four-wire, enrolling machines, stuff like that.

Dusti: Yeah we do all that. Multi Media that's all it is, linking machine to machine and linking that to the back server.

STM: Do you get to play with the server at all?

Dusti: Actually, within the last couple of days they decided to have a server tech team.

Lena: Which is all men!

STM: Ah, it's starting to happen already. Are you going to let them take over on you, or what?

Dusti: They're trying, but it's going to take a lot, because all of us are smarter than they are. [giggles from all]

STM: That reminds me, who makes the better tech, a man or a woman?

Cindy: A woman does.

Dusti: We have been told over and over again that women make better techs because women take the time. They think about it. They don't just jump in and fix.

Lena: And we don't do the quick fix.

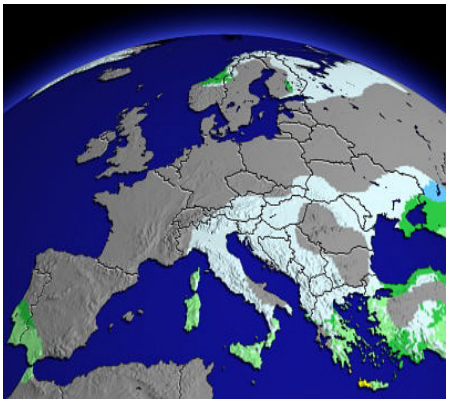
Dusti: [The men] will sit there for a half an hour, before they ask one of us. Then we'll go over there and act like we're not doing anything. Then we push one button and fix it and they'll just sit there like dumbasses.

By the way gentlemen, not only do these Queens of the Slot Floor do it all, all but one is somebody's Mom.♣

- Ken Locke
ken.locke@igt.com

International View

By Martin Dempsey



CashCode Exhibits At ICE Show

CashCode Co. Inc, the world leader in banknote validation technology, has once again exhibited at the ICE Show in London, England from January 22 to 24, 2002. This year marked the third time CashCode has exhibited at ICE, one of the biggest and most successful international gaming shows in Europe.

"We at CashCode are glad to participate in a show as successful as ICE", stated CashCode spokesperson Jenna Snyder, "ICE is to the casino and gambling industry what Babe Ruth is to baseball. It will be an excellent vehicle through which to promote our cutting-edge banknote validators."

CashCode exhibited its products at booth 5260, where the MFL (Multi-width Front-Load) Bill Validator and new VU stackerless unit were showcased. The MFL stacking and VU stackerless units both feature multi-width note or coupon acceptance, as well as barcode and smart card technology.

For further information, please contact
Jenna Snyder,
CashCode Co. Inc.
Phone + 1 905-303-8874, ext 2304.

Coinmaster Races Ahead At EELEX 2001

Cardiff based Coinmaster Gaming Ltd introduced their latest game "Winning Post" at this year's EELEX. This multi player video game incorporates the latest in pc based interactive gaming which eliminates the problems traditionally caused by mechanical parts in other games of this type.

EELEX visitors were impressed by the quality of the graphics and the large 18.1 inch screen player terminals that allow the player to be directly involved by using the interactive whip button to spur the horses on. Betting options are varied which keeps players interested for longer thereby ensuring longer visits to the machine leading to increased take. On-lookers can view the action by watching the larger main 42 inch plasma screen.

Having variable race lengths and differing racing surfaces add further enjoyment. This means that players must look at the horses "form" on differing surface types and race lengths to assess its chances of winning and increases the overall playing experience.

During the show Winning Post was hardly ever without players, which proved the popularity of this type of game and the attraction of the Coinmaster design. With the option of up to 250 terminals this game is ideal for all types of gaming establishment.

"We expected interest" commented Sales Director Ken Kennedy "but nothing like this."

The normal lull to be expected at various times during exhibitions didn't occur, with visitors of all ages and from all Russian and CIS countries queuing to try Winning Post out.

Coinmaster distributes its products in Russia and CIS through Unicum. For further details of Coinmaster products please contact ++44 (0)2920 2064 9500 or e-mail sales@coinmaster-gaming.com

No stranger to horse racing games, Coinmaster Gaming also manufactures the two-player Derby Day.

Huxley & Maygay Unveil New Gaming Alliance

Two of the biggest and best names from opposite ends of the gaming spectrum celebrated Christmas with the announcement of a thrilling new product development alliance, the first fruits of which will be on displayed on their respectively dominant exhibition stands at ICE 2002 and ATEI 2002.

John Huxley, the leading manufacturer and supplier of traditional live gaming equipment to the international casino sector, has joined forces with the Maygay Group, leaders in the development and manufacture of AWP machines and coin-operated trivia quiz and video gaming content. Having recognised areas in which such a partnership could deliver mutual benefits, the two companies have spent several months in discussion.

The clear conclusion is that as their respective core markets converge, the opportunities to share resources and expertise become self-evident. It is intended that the result of this partnership will be a series of video-based casino games that combine Huxley's unrivalled global gaming expertise and infrastructure with the superior technologies and hugely cost-effective manufacturing resources of Maygay.

Commenting on this exciting and far-reaching agreement, Huxley's Jeffrey Lindsay said: "This partnership is very much a meeting of minds. As our markets moved ever closer, and ours became more technology-driven, Maygay recognised a need to forge alliances within the casino sector in order to gain entry. At the same time, we knew that we needed to develop the electronic and technical side of our product portfolio."

It is true to say that from the very first meeting, both parties were certain that they had come to the right place.

For further information contact Maygay Machines - Nick Hardy, Group Marketing Manager.
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E-mail: nick@maygay.com
or John Huxley - Tracy Cohen, Marketing Manager.
Tel: +44 208 803 3038.:
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Novo Gaming UK Ltd

On stand number 700, Novo Gaming made its entry at ATEI with an exciting variety of AWP products for various markets, whilst parent company Novomatic was prominently placed in the ICE Hall.

For the UK market, Novo Gaming introduced the multi-game, video based AWP, Magic Games Interactive, which includes the highly successful Jokers Wild poker game and Always Hot, a low-tech, reel based AWP that has already achieved significant success in a number of other European markets.

sNovo Gaming expects, as do other manufacturers, that the British market will move towards easily upgraded video based machines. These products have the advantage of staying on location for longer periods, with simple changes to top earning games being available as upgrades, when the machine needs a fresh appeal. Magic Games Interactive, were presented in the Classic Series casino cabinet, which has met with great success worldwide and should achieve similar impact in the UK.

Also seen on stand 700 was the Magic Games fungame especially developed for the German market. Housed in its attractive yet practical cabinet for fungame operation, this product should also be viewed with a great deal of enthusiasm.

To confirm the emphasis on European markets, also to be found will be the Action Runner and Hot Chip Runner games which are already successful products in the Czech Republic and Hungary. Additionally, the multi-game Tri Star specifically targeted at the Norwegian market will also be well worth close inspection.

For further information contact Phil Thomas, Director of Marketing & Sales, NOVO GAMING UK LIMITED.
Tel: + 44 7736 674 331

The Latest German Fungame From Cretus Is Called Memphis

The 3-reel bottom game can be played with stake 1, 3, and 5 points. Prizes can either be risked up to 5,000 points on the gamble trail or transferred to the top game. Points can also be converted directly into Pyramid games. The top game is played with stake 10, 30 and 50 points on 5 winlines, Pyramid games are played on 27 winlines. In the Pyramid game, players can win the Memphis games. During these Memphis games (which are played for free) the player has a repeated chance to gamble the higher prizes up to 5,000 points. The Scarab symbols can fill up "Memphis" and award an extra Jackpot to the player. For more information contact JVH gaming products GmbH.
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Introducing the Medeco® High Security Cabinet Locks

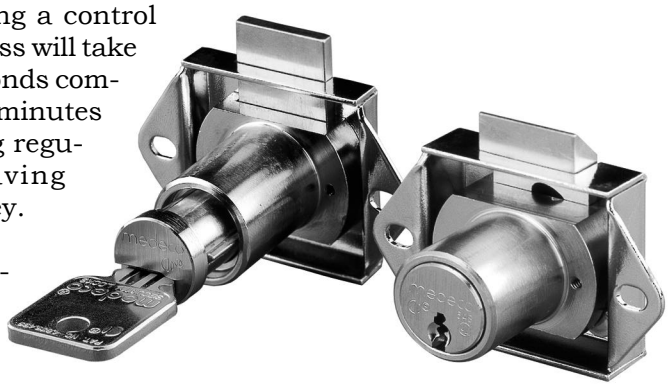
Medeco has recently added a new addition to their line of high security locks for gaming applications, the Medeco cabinet locks. The Cabinet locks compliment a full line of Medeco gaming locks, and can be used on cash drawers, drop bases or any other heavy duty application. Cabinet locks provide strong physical security and patented protected key control. Medeco's cabinet locks are available in Biaxial® or DuraCam® keyways and in standard or removable core versions. Additionally cabinet locks can be keyed to match previously installed Medeco 60 series product.

The DuraCam version of the cabinet locks comes with a thicker top cut key to help prevent key breakage and is guaranteed for life against breakage.

Similarly, the DuraCam II, removable core version of the cabinet lock also comes with a thicker top cut key, plus provides the ability to change locks quickly and easily in case of lost or stolen keys by simply swapping the old core for a new one using a control key. This process will take a matter of seconds compared to costly minutes when changing regular locks, saving time and money.

With the features of strong physical security, patented key control, key strength, and a removable core, Medeco cabinet locks are the perfect addition to the already full line of Medeco gaming products.

For more information on the Medeco cabinet locks call 1-888-633-3261 or check us out on the web at www.medeco.com.



HK Shorts

Heater-to-Cathode Short? Put a Long in it!

Each of the three electron guns in the electron gun assembly uses a heated cathode as a source of electrons. The heater is the element that you see glowing when you look at the neck of a picture tube. The heater must fit closely inside the metal cathode but it must not touch it. If the heater shorts to the cathode, the gun will be stuck "ON" and the screen will appear a super bright color (red, green or blue depending on which of the three guns is affected) with vertical retrace lines visible throughout the screen. Vertical retrace lines appear as diagonal lines that run from lower left to upper right across the screen.

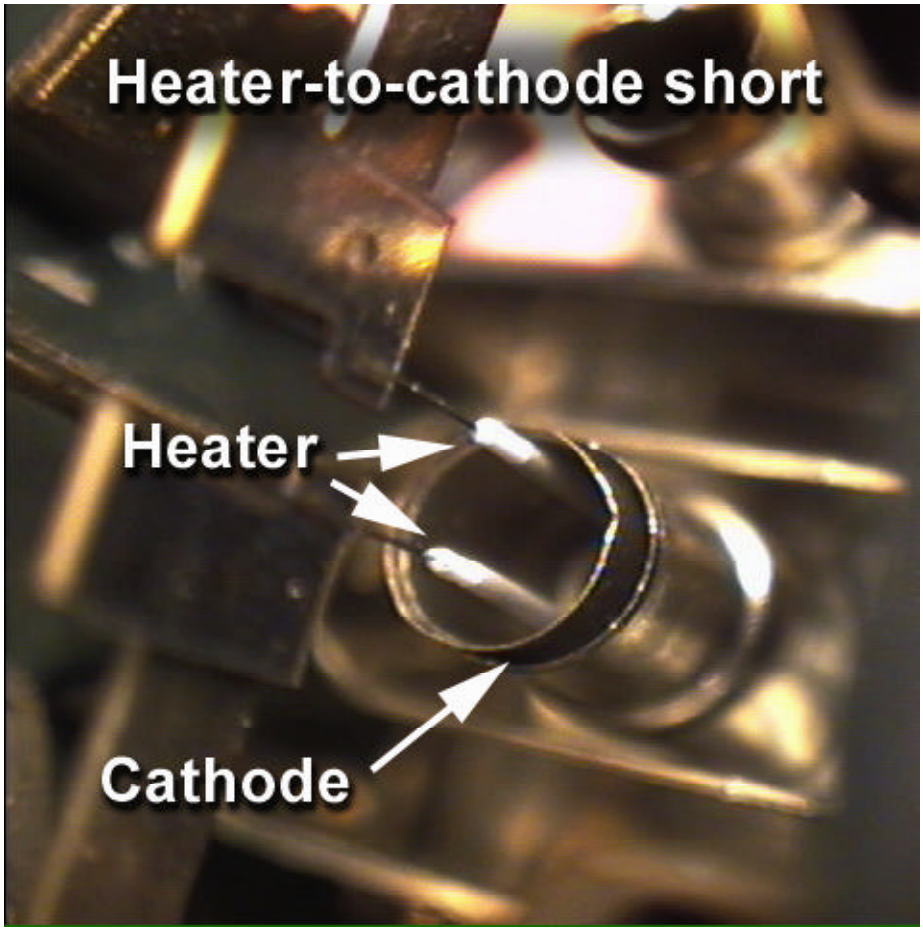
If you believe you might have a heater-to-cathode short, try unsoldering and removing the associated video output transistor from the neck board of the monitor. Fire up the monitor with the transistor removed. If you still have a brightly colored screen with vertical retrace lines, there's a good chance the CRT has a heater-to-cathode short.

You should be able to verify this with an ohmeter. With the neck board removed from the CRT, you should have an infinite resistance between heater and cathode of the picture tube. Although there are many different types of CRTs, you will often find the red cathode at pin 8, the green cathode at pin 6, and the blue cathode at pin 11. Pins 9 and 10 are for the heater.

Fixing the Symptom, Not the Cause

In the past, I had always concentrated on repairing the CRT itself; blowing away the short with a burst of current from a capacitive discharge. The real point is that we need to remove the unwanted ground connection to the cathode. We don't necessarily have to remove the heater-to-cathode connection, as long as neither the heater nor the cathode are grounded.

With that in mind, let's look at four different ways to get around the fact that we have a shorted CRT, without having to replace the CRT itself. Two of these methods use a transformer to isolate the heater connection from ground, the other two require only a slight modification of the high voltage unit



and heater connections.

Remember that the problem lies in the fact that one side of the flyback transformer winding is connected to ground and, naturally, one side of the CRT heater is as well. However, this is only done for the sake of convenience of wiring. It saves one wire (the return path) between the main printed circuit board and the neck board. It is not necessary (electronically speaking) to have one side of the CRT heater grounded. If we can break this ground connection, the heater will no longer be grounded and the defective electron gun will no longer be activated due to the HK short.

Start by locating the two heater pins on the neck board. These are often pins 9 and 10. Likewise, the two pins are often labeled "H" for heater or "F" for filament. One of the pins will be grounded. This should be pretty obvious just by looking at the neck board. One of the two heater pins will be connected to a large expanse of PCB conductor (the "trace"). If you cannot determine which pin is grounded by observation or by referring to the schematic diagram, you can use an ohmeter or continuity tester to determine the grounded heater pin. Just put one meter lead on the metal frame of the monitor and touch the other meter lead to each of the two heater pins one the neck board in turn. One pin will indicate continuity, the other will not.

NOTE: You must remove the neck board from the CRT in order to make this test. The CRT heater has a very low resistance (maybe an ohm or two when cold) and, as such, the ground connection will seem to appear on BOTH pins if the neck board is installed on the CRT itself.

Once you've located the heater ground, your next step is to isolate the pin from ground. Typically, this means using a razor knife or "MotoTool" (a hand-held, high speed grinder) to cut away the copper foil of the printed circuit board that connects ground to the heater pin. For goodness sake, be careful here. Try not to butcher the printed circuit board and don't stab yourself with the razor knife as you're slicing through the foil. You don't have to cut much, just create a thin gap to break the ground connection.

Next, you'll have to do the same thing at the high-voltage unit (A.K.A. flyback transformer) where you'll find the other ground connection. This may be a bit trickier as the ground connection here is often a fairly massive island of copper foil. Again, use a razor knife or grinder to isolate the ground connection from the CRT heater winding of the flyback transformer.

NOTE: Many monitors use a high-voltage unit with a common ground pin for both the high voltage winding and the heater winding. Unfortunately, this modification WILL NOT WORK on any monitor with a common ground for the CRT heater winding and ANY OTHER WINDING. If this is your situation, you'll have to use one of the other "transformer-based" solutions described below.

With the ground connections isolated at both the flyback transformer and the heater connections on the neck board, all that's left to do is to add a single wire between the two isolated points, completing the CRT heater circuit. You now have a complete circuit that powers the CRT heater WITHOUT a connection to ground. Since the heater is no longer grounded, the heater-to-cathode short no longer has any effect on the electron gun and you're back to business as usual (not to mention the fact that you've just saved to boss a bunch of money by not having to purchase a new CRT or entire replacement monitor!)

Isolation by Transformer

If you're working on a monitor with a heater-to-cathode short in the CRT but the high-voltage unit has a common ground between the secondary windings, you cannot isolate the CRT ground by simply cutting the ground traces. To do so would also break the return path for

the other windings as well.

In this case, we need to find another way to isolate the CRT heater from ground. When you talk about "isolation" one component comes to mind: the transformer. Most technicians are familiar with the "isolation transformer." This is a safety transformer often used to provide the AC power to a monitor, especially one under test on the bench. In this case, the isolation transformer is used to break the neutral/ground connection of the AC power, allowing us to connect an oscilloscope the normally "hot" primary side of the monitor's switched-mode power supply (SMPS) without vaporizing the ground lead of the 'scope probe. The isolation transformer also allows us the ground the SMPS ground to the "Earth ground" without blowing up the monitor's power supply.

But we cannot use an ordinary isolation transformer here. The CRT heater is driven by a winding on the flyback transformer in the high voltage unit (See Slot Tech Magazine, January, 2002, page 29). The flyback operates at 15,750 hz on a standard resolution monitor, 31 kHz in a VGA monitor. A normal isolation transformer is designed to operate at 60 Hz. Its heavy, iron core prohibits its use at higher frequencies.

However, a special CRT heater isolation transformer is available at most good electronics shops or thorough mail order from the major electronics parts houses. It's generally referred to as a "CRT heater isolation transformer" or something to that effect. The unit has a male and female socket at either end and plugs right in between the CRT and the CRT socket. A CRT booster or CRT brightener will also isolate the CRT heater.

Also, there is another way to isolate the CRT heaters using a small 6.3 volt transformer from Radio Shack.

1. Disconnect the wire that leads from the main board to the heater connection on the neck board.

2. Isolate the grounded CRT heater connection on the

neck board as described above.

3. Connect the primary winding to the AC input of the monitor (after the fuse, just in case!)

4. Connect the secondary winding of the transformer to the CRT heater pins on the neck board.

The CRT heater will now be powered by the 6.3 volt output of the transformer instead of the winding on the flyback transformer. Since the output winding of the transformer is, by its very nature, isolated, the heater is no longer grounded and the heater-to-cathode short doesn't make any difference. This cures the symptom (the bright screen) without actually curing the problem, the heater-to-cathode short!

The Trickiest of All

Okay . . . If you're still with me, here is the trickiest trick of them all. In fact, this is really the best way to solve this problem. The other stuff was presented more for its educational value than anything else.

Start by isolating the two heater pins on the neck board as you did before, by cutting the PCB traces with a razor knife or Moto-tool. Now this is where the procedure departs from our previous discussion. Next, unsolder and remove the wire that connects the ungrounded side of the CRT heater to the flyback transformer.

An alternative method to the whole slice and dice thingy is to unsolder and remove the CRT socket from the neck PCB (leave the focus wire in place). Enlarge the two holes for the heater pins by drilling them out and replace and resolder the CRT socket (all except the two heater pins, of course). You won't be soldering the CRT socket pins to the PCB anymore. Later, you'll be soldering wires directly to the two pins. Make the holes substantially larger in order to give you room for the wire and room to work with the soldering iron. The heater is now totally isolated from everything else.

Roll Your Own

I guess "wind your own" is really more accurate as what you're about to do is wind your own secondary winding on the exposed ferrite core of the flyback transformer. This is not nearly as involved as it sounds because you're only taking two or three turns around the core. Just grab eighteen inches of insulated wire. You can salvage a bit from an old wire harness. Number sixteen wire works fine. There will only be about an amp of current flowing so wire size isn't critical. Pass the wire through the gap between the body of the flyback and the ferrite core and wrap it around the core twice as shown in figure 2. When wrapped as shown, you actually have two and one-half turns.

Why am I being picky about a measly half turn? Well, you'll be amazed at how much voltage is generated by the little secondary winding you've just created. More about that in a moment but for now, solder the two ends of the wire to the two, isolated CRT heater pins.

You now have a complete circuit that powers the CRT heater WITHOUT a connection to ground. Since the heater is no longer grounded, the heater-to-cathode short no longer has any effect on the electron gun and you're back to business.

Power up the monitor and see if it works properly now. If it does, you've fixed the problem and you're ready to experiment with the next phase of this fun little project in resurrecting an otherwise completely useless CRT.

CRT Brighter

There's another little side benefit to this new flyback secondary you've just created. Since the number of turns of wire determines the output voltage of winding, you can increase the CRT heater voltage by adding an extra half or full turn of wire around the core. This trick is really a poor man's CRT rejuvenator/brighter. When you have an really old CRT that's on its last legs with poor emission from all three guns, boosting the heater voltage will increase the electron emission, restoring acceptable brightness in most cases.

Actually you can try this on any monitor without having to isolate the heater (as long as you don't have a heater-to-cathode short, of course) or create a dedicated secondary winding. Simply disconnect one end of the CRT

heater wire that connects between the main PCB and the neck board.

Next, Pass this wire around the flyback core (making one-half to one full turn around the core) and reconnect it to where it was. Fire up the monitor and see what you have. You'll see one of two things: Either the picture will be noticeably brighter or it will noticeably dimmer. You see, that extra loop you just added around the flyback is really a one-volt secondary winding. You are connecting this in series with the existing CRT heater winding in the flyback transformer.

But if the two windings are sources connected in series wouldn't that automatically add the voltages? Not if the "phases" of the two windings are 180 degrees apart. Phase is to AC what polarity is DC. If two AC sources in series are out of phase, one winding subtracts from the other one. If the two are in phase, they add together.

Editor's note: The best way to restore a dim CRT is with THIS gizmo, the CR7000.

➔➔➔➔➔➔➔➔➔➔➔➔➔➔

If your picture (and the CRT heater) is dimmer than it was before you started, disconnect the wire and wrap it around the core in the opposite direction. That will reverse the phase and you'll be in business.

You can experiment with this and see what works best in each monitor. Naturally, this is only a last ditch effort to extend the life of an otherwise unusable CRT. Boosting the CRT heater voltage of a good CRT will reduce its life expectancy.

Open Heater Circuit

By Frank Sutter

So here's the scene. You're cruising the casino floor, fat, dumb and happy, when out of the corner of your eye, you notice a customer motioning frantically to get your attention and bring you over to their machine. When you arrive, you are told that the picture on the monitor is going away. You look at the picture and it looks perfect. Naturally, you begin to explain to the customer that you don't see anything wrong with the machine, when the customer looks at you smugly and says "Just watch."

It's part of being a slot technician to be as polite to the customers as you can manage, so you decide to humor the patron for a minute or two. Just as you are trying to find the words to explain to the patron that the machine looks the way it is supposed to look without making the patron feel too dumb, the picture begins to fade out. The colors begin to dim, then become pale, and in about four or five seconds, the picture is gone altogether and you're looking at a black screen. By now, the patron is quite amused at the startled look on your face and he says, "Just keep watching." By now, you are quite intrigued and you really have little choice.

Sure enough, in about a minute, you see the picture coming back up. First, you see the faint outlines of the picture form up on the screen, and then it begins to color-in brighter and brighter until the game once again appears normal. You are looking at one sick monitor and it's going to have to go to the shop for repairs. While this one looks strange, this is a situation you will be able to remedy inside of twenty minutes. I have only seen one model of monitor ever exhibit this problem, and it's a tribute to the durability of the brand name, Ceronix. In this case, the electronics have actually outlasted the life of the solder that holds those components together!

The first step is to make sure that the customer is happy. The best way to do this is to find an unused, nearby game that has an identical monitor and shut it down. Remove the working monitor and mark the game as down. Next, open the failing game, remove the failing monitor and install the known-good one. Sign the needed paperwork and get out of the way so that the customer can continue to pump coinage into the now-working game. What you have now is a working game, a happy customer, a failing monitor in your hand and a game that has no display system.

Bring the monitor to the electronics repair shop, where you are about to find out how God loves you. If you abide in His favor, there will be a replacement unit on the shelf. You can simply grab a working model, tag the bad boy with the symptoms observed and leave the unit for the electronic guys to repair. If there is no replacement available however, this problem is one that even the inexperienced tech can handle in just a few minutes. Don't worry, God loves you even when you have to work hard.

There is a lot of heat that develops on the inside of a slot machine in normal operation. The cause of the failure you observed was a direct result of the components on the printed circuit board of the monitor outlasting the solder that holds them in place. In the universe of circuit board repair, this is not a common failure because it requires just the right combination of hostile environment, sturdy components, and time.

Here's how it happens: The picture tube has a socket to attach it to the main board. In the Ceronix model, this socket is mounted on a small printed circuit board that is referred to as either the CRT socket board or the neck board. Where the socket is soldered to the neck board, you will find a semicircle of solder nodules. Each of these carries a different signal to the picture tube in order to produce an image on the screen. The heat generated by the normal operation of the unit has softened the solder on the neck board and

over time, this process actually loosens the connections on the picture tube.

Two of these connections are carrying current to the filament of the tube. The job of the filament is to heat the cathode of the tube so hot that it can emit electrons. These freed electrons stream towards the high voltage at the screen of the picture tube so that they strike the phosphors coating the inside of the screen and make it glow. The beam is controlled electronically to strike one particular point of the face plate at any given instant and the color of the phosphor struck combined with the intensity of the beam, which controls how brightly the phosphor glows, are the elements that define the picture.

The filament (or heater) is essentially nothing more then a short length of toaster wire. It functions in exactly the same way. With that knowledge, it should be readily understood that a considerable amount of current is required in order to create the necessary heat. While some current paths have less inherent resistance then others, all electrical paths have some level of resistance. The greater the intensity of the current, the greater the resistive effect. In the process of pushing through the resistance, the current generates heat. Over time, the heat softens the solder nodes of the filament even more then the ambient heat of the machine's normal operation and in this elasticized state, the solder has the chance to flow away from the joint. As the connection loses it's percentage of surface contact, resistance to current flow goes up thus the amount of heat generated as the current flows goes up as well. This greatly accelerates the softening process and promotes the flow of the solder away from the joint.

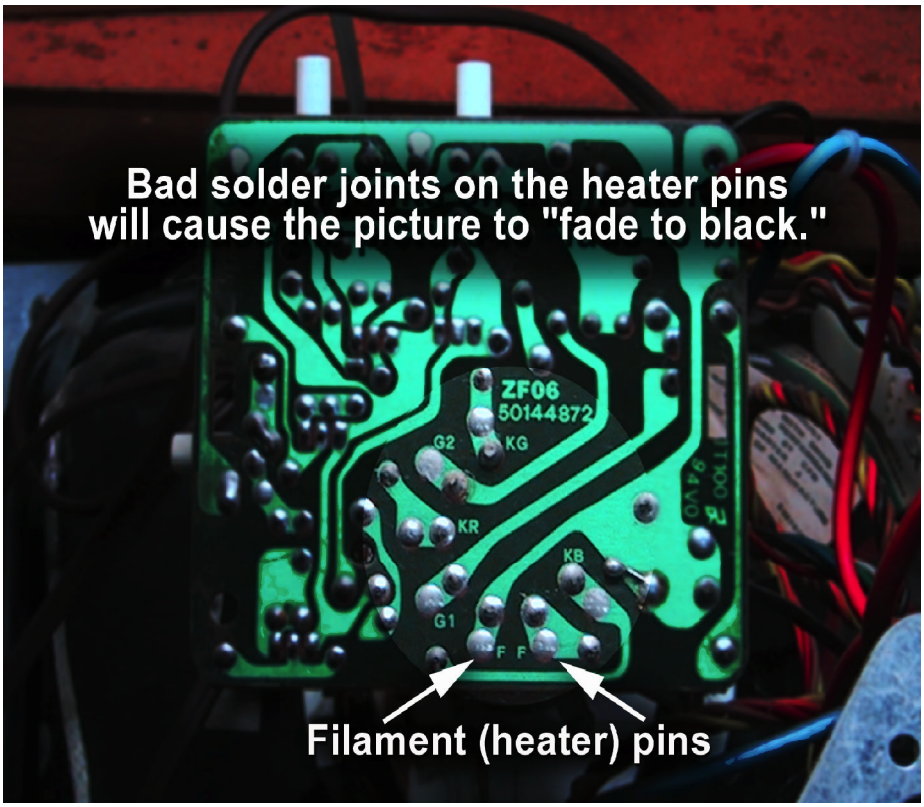
The cure is pretty easy. Simply heat up the soldering iron and reheat all the solder joints connecting the tube socket to the neck board. When you perform this operation, you must add a bit of fresh solder to the old material. The heat and the new solder (along with the flux inside its hollow core) will allow a new alloy to form and it will be almost as good as new. If you have a bit more time and you want to truly make it as good as new, remove the old solder altogether, and re-solder the joints with new solder.

You will need a signal source in order to hook the unit up, but in shops that repair Ceronix Monitors, the signals to drive an outboard monitor are built in to the IGT board tester. You will find the outlet to plug into mounted on the side of the tester and the cable required should be in the immediate vicinity.

Make sure the power is off on the tester, and connect the video cable to the back of the monitor. It will only plug in one way and power is included in this wire bundle, so one connection takes care of everything. Power the unit up and confirm the problem has been cured.

For more on the CRT heater circuit, see "HK Shorts" on page 21 of this issue of Slot Tech Magazine.

Sometimes the most bizarre looking problems are the easiest to fix. I hope this quick fix helps at some point down the road. Until next time, keep 'em runnin!



TechFest II - Sold Out!

Sixty-four slot techs from across the continental United States and as far away as Puerto Rico, Japan and Korea joined the gaming industry's top engineers, technicians, technical writers and instructors for 3 days of technical seminars and presentations at TechFest II.

The sold-out event was held at the Las Vegas facility of Happ Controls in Las Vegas, Nevada and featured presentations from: Asahi Seiko, Coin Mechanisms, Inc., JCM, Mars, 3M Touchsystems (MicroTouch) Sencore, Global Payment Technologies and Medeco High Security Locks .

Top: Sencore's Gary Morinville discussed test equipment for monitor repair.

Bottom: JCM's Jack Geller (r) discusses the WBA bill validator with Randall Henderson of WMS Gaming (l) while Bryce Teeple of Bay Mills Resort & Casino (Brimley, MI) examines the unit.

Slot techs from around the country and as far away as Japan and Korea enjoyed three days of technical presentations at TechFest II. For a high-resolution look, visit the website at slot-techs.com/techfest

Attendees included: Bryce Teeple, Dale Murphy, Bay Mills Resort & Casino, Kellie Conley, Soloman Goodsell, Dakota Connection, John Welch, Jacob Barse, Tim Greenfield, Dakota Souix Casino, James Blanks, Mitchell Raymond, Games, Etc., Rickey Alexander, Neil Carpenter, Harvey's Wagon Wheel Hotel & Casino, David Petrone, Imperial Casino & Hotel, Ralph Martinez, Roger Brown Mardi Gras Casino, Alice King , Victor Naj, Speaking Rock Casino, George Feick, Jesse G. Rodriguez, Rita Medina, Spirit Mountain Casino, Randall Henderson, WMS Gaming, Inc., Joe Beebe, Shawn Beaudry, Mill Casino & Hotel, Thomas A. Stuart, Viejas Casino, Ray Lopez, Henry Griego, Michael Lucero, Michael Antonio, Isleta Casino & Resort, Richard Reeber Jaime "Rick" Gardaya, US Air Force, Ron Rosenow, Daymion Thomas, Chris McLaughlin, Lucky Eagle Casino, Charlie Minniear, Joe Bard, Eric Luers, Gerald Augustine, Riverside Resort and Casino, Heidi Schmidt-Cool, A.L.M. Corp., David Barreno, Jose Ingaran, Games "R" Us, Rodney Justice, Calvin Miller, W.C.W. Corporation, Dave Parks, Scott Wolatz, Riviera Hotel & Casino, Randy Tate, Sky Ute Casino. Tanya Norman. Motor City Casino. Pablo Rivera. Tropical Casino, Scott Dennen, Sierra Design Group, Rick Long, Gary Williams, Ernie Brooks, Eli Williams, Colville Tribal Casinos, Beth Wroblewski, A.S.T.I.,Leticia Ochoa, Terrence Rose, Cole Industries, Inc., Don Beard, Damion Lopez, Spotlight 29 Casino, Mitch Frazier, Charles La Rocca, Don Rollins, John McHugh, Sycuan Casino, Curtis McClain, Mike Browne, Isle of Capri - Blackhawk

Switching Regulator Power Supplies

We live in a "disposable society." Disposable razors, lighters, pens and a myriad of other items are a part of our daily life. Many slot operators consider power supplies to be disposable as well. Their rumored inability to be repaired and relatively low cost create the impression of disposability.

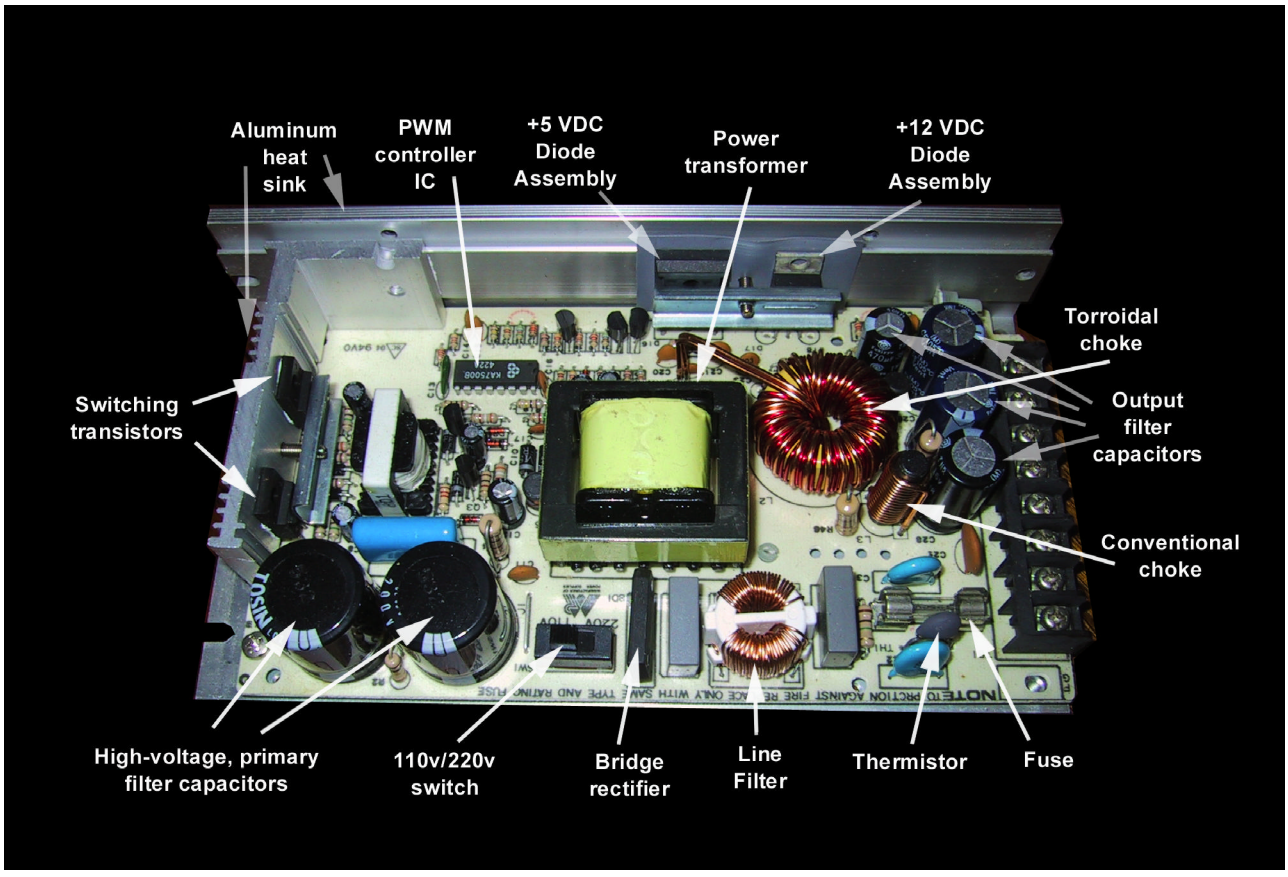
This is not the case, however. It's really quite easy and practical to fix power supplies. It can be a lot of fun, too. A repaired supply may even end up having a longer life expectancy than a new one, as you'll see.

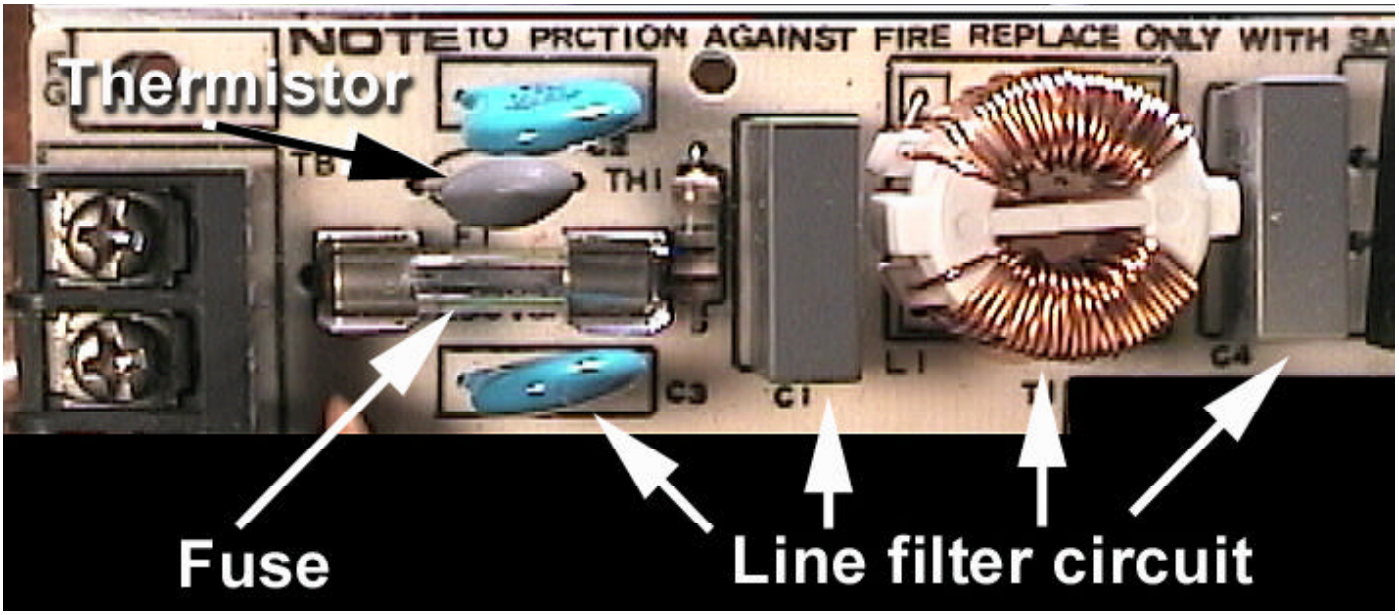
Power Supply Operation

Modern slot machines use power supplies that are known as "switching regulator power supplies." Most switching power supplies are a snap to repair, once you become familiar with the common component failures. We'll get to those components later but first, let's take a look at the switching supply and see how it operates.

As we know, the purpose of the power supply is to change alternating current into direct current (See Slot Tech Magazine, December, 2001, page 28). At the same time, the power supplies under discussion here will also lower the voltage from 120 volts (or 220/240 volts, depending on where in the world the machine is being operated) to low voltage outputs such as 24 volts, 13 volts, 12 volts, 5 volts or even 3.3 volts. Naturally, all of these output voltages are DC.

The 120 VAC input generally is connected to the power supply via an input connector. Some open frame power supplies use a screw terminal strip for the connections. The first thing that happens



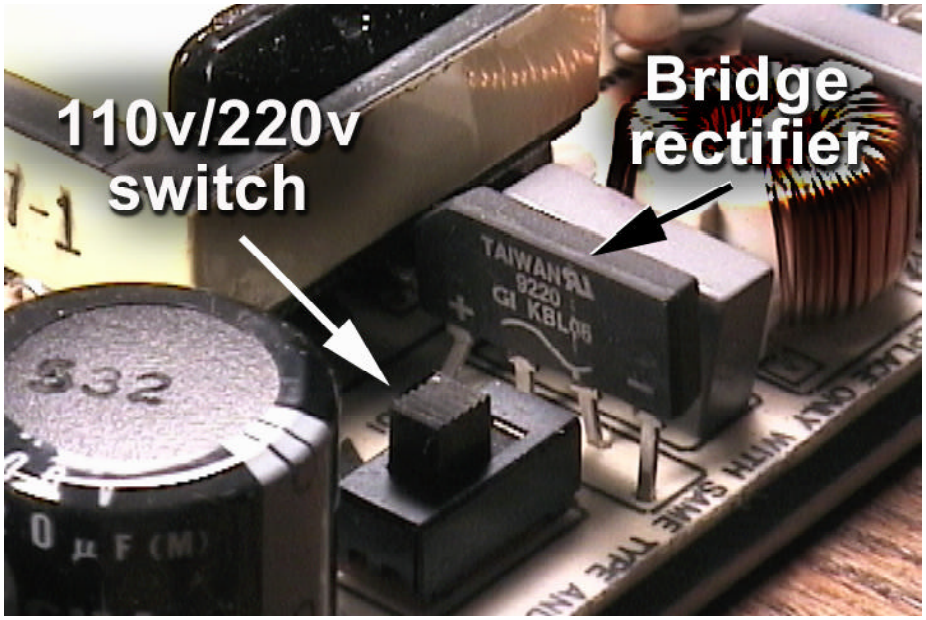


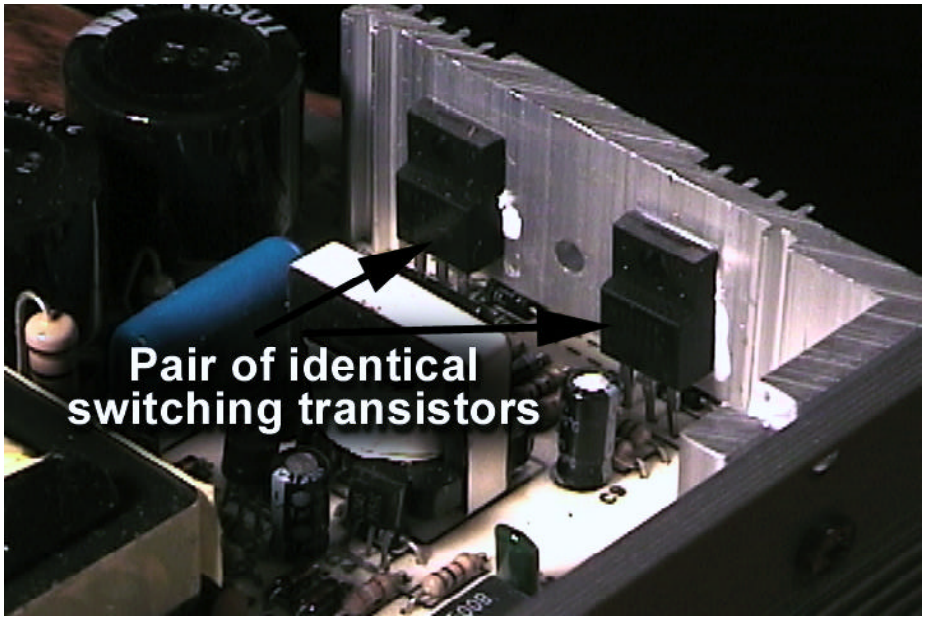
to the 120 VAC is that it is passed through a fuse. Following the fuse, the 120 VAC is then passed through something known as a "line filter." We see line filters in all types of equipment. For more information about line filters, please see the companion piece in this issue of Slot Tech Magazine, "EMI-a-Go-Go".

After passing through a fuse and an AC line filter, the 120 volt AC input is rectified by a bridge rectifier. An interesting feature of most of these types of switching regulator power supplies is that they have the ability to work off of a 120 VAC or 240 VAC input. When connected for 120 VAC, only half of the bridge is actually being used. One of the two "+" diodes is used to create a positive, half-wave power supply while one of the two "-" diodes is used to create a negative, half-wave power supply. When connected for a 240 VAC input, the entire bridge rectifier is used, with its output voltage divided in half and referenced in the middle to create the same outputs.

After passing through the bridge rectifier, the DC is then filtered by a pair of high voltage, electrolytic capacitors. Typical value for these capacitors is 150 to 220 microfarads, 200 VDC. This creates two, high-voltage, DC power supplies; one positive and the other negative. Both are approximately 160-170 volts.

So far, this looks just like the linear power supplies we looked at in December's issue but now, things take a radical departure. A pair of switching transistors is then used to switch these high voltage supplies across the primary winding of a power transformer. This switching action is very fast. A typical switching speed is around 40,000 cycles per second or 40 kilohertz. In some cases, it's even higher. 100 kHz





switching is not uncommon.

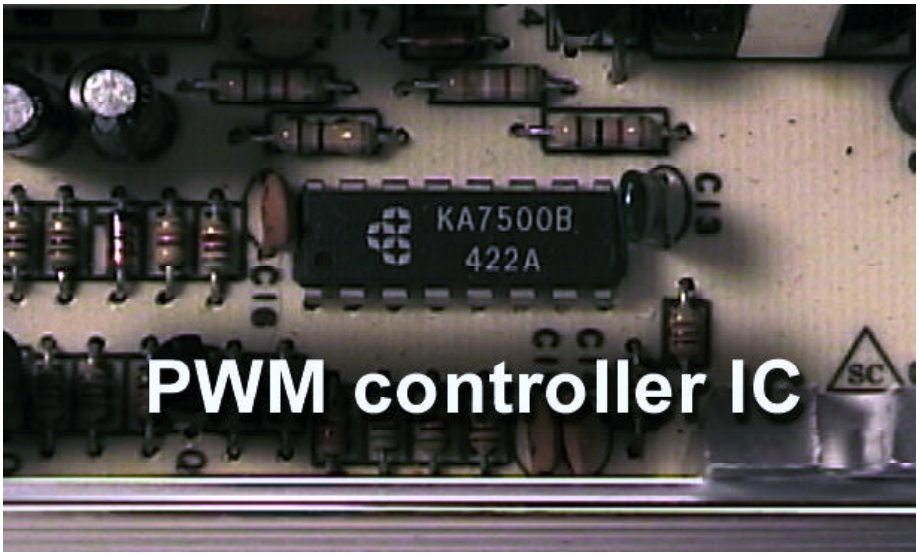
But wait a second! A transformer is strictly an AC device. A transformer won't work with DC and yet here, we seemingly have the DC outputs of the two, 160 VDC power supplies connected through the transistors to the primary winding of the transformer. What's up with that? Well, in fact we are really not putting DC on the transformer's primary. Here's the deal . . .

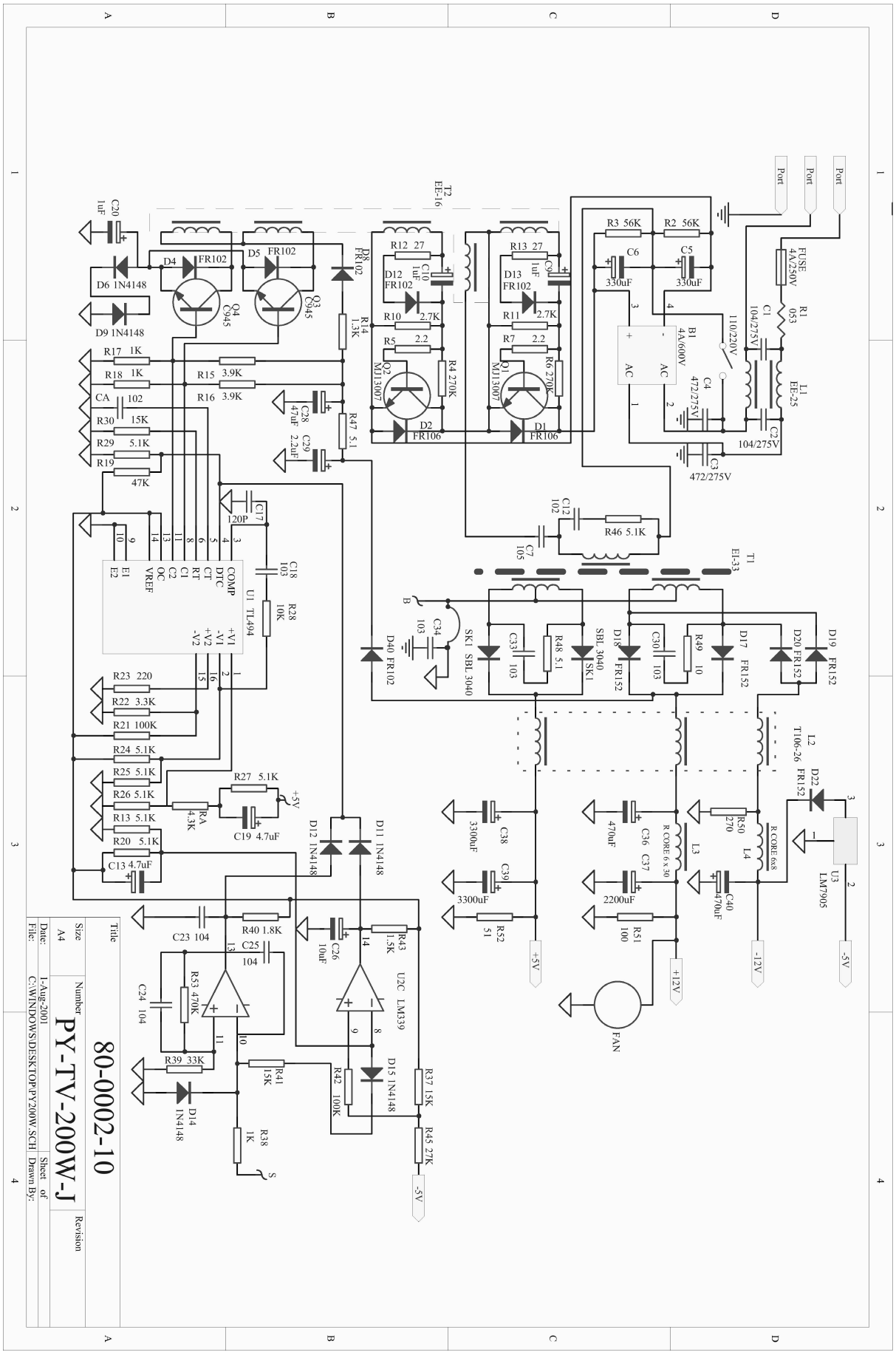
Only one of these switching transistors is energized at a time. They are NEVER energized simultaneously as that would connect the output of the +160 VDC power supply directly to the output of the -160 VDC power supply, destroying the switching transistors and blowing the fuse. Instead, first the +160 VDC is connected to the primary winding of the transformer through switching transistor Q1. After a short period of time (a tiny fraction of a second) Q1 is turned off and a short while later, switching transistor Q2 is turned on for a short period of time (again, a tiny fraction of a second). Then, Q2 is turned off and the process is repeated forty thousand times a second. Since we are first connecting the + power supply and then the - power supply, we are actually putting AC on the primary winding of the power transformer, not DC. But it isn't AC at 50/60Hz (the frequency of the AC power coming from the wall receptacle or "mains") it is AC at 40 kHz! It's also interesting to note that this AC is not a sine wave as it is coming from the AC mains. It is instead, something called a "pseudo-sine wave" as shown in Figure X.

Why would we want to go through all of that trouble when we know that it's perfectly possible to transform the 50/60 Hz AC? The answer lies with the transformer itself. As we learned in the October, 2001 issue of Slot Tech Magazine, operation at high frequency allows a power supply to use a much lighter, smaller and WAY less expensive ferrite-core transformer instead of the large, heavy and much more expensive iron-core transformer that is required by a linear power supply.

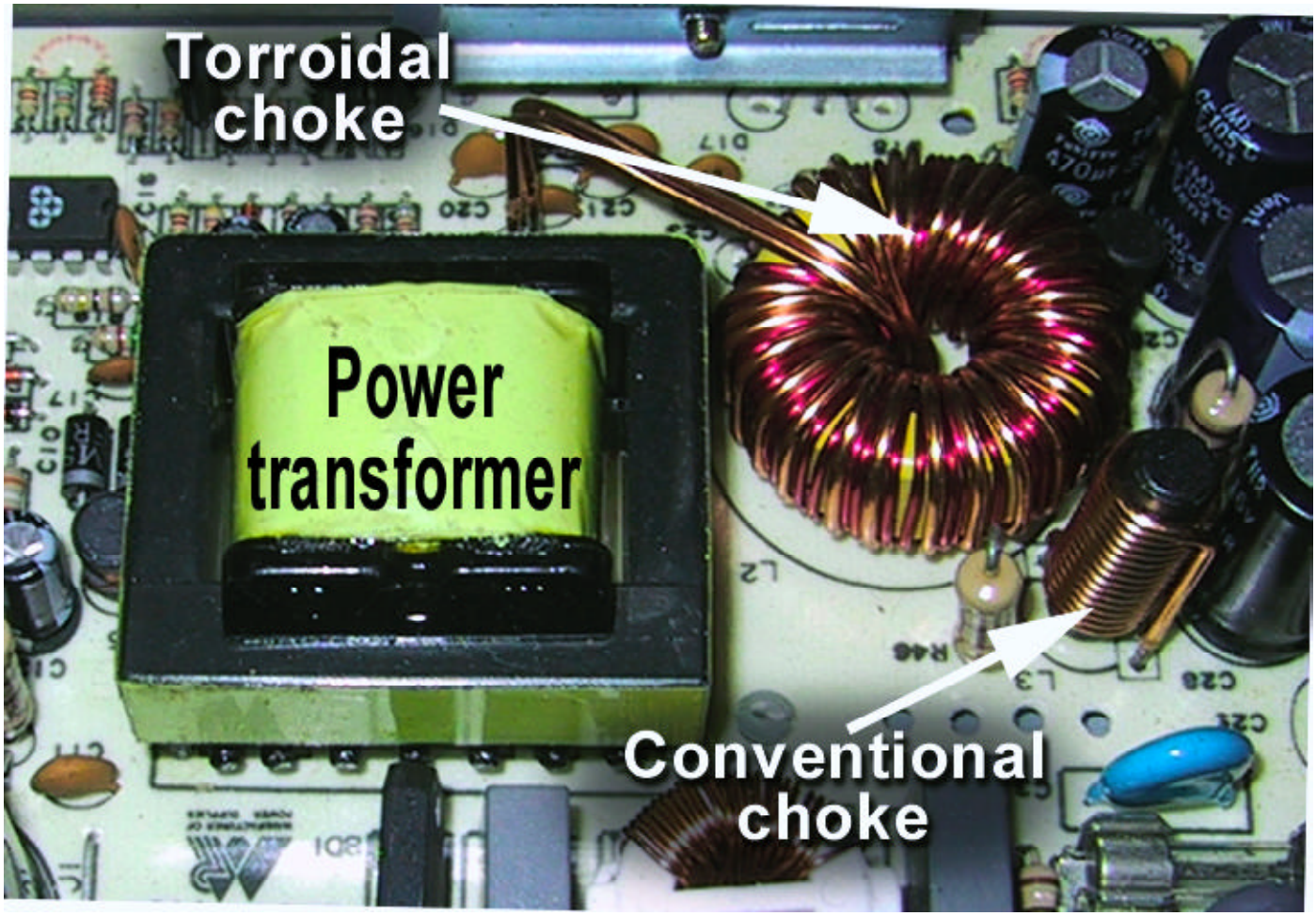
PWM

In addition to allowing us to use a ferrite-core transformer, this scheme also allows us to regulate the output voltage of the power supply in a much more efficient manner than the heat-wast-





Typical Switching Power Supply, courtesy of Pan Yes Electronics and Happ Controls.
Slot Tech Magazine encourages its readers to purchase replacement power supplies from those responsible vendors who provide schematic diagrams.



ing, series-pass voltage regulator in a linear power supply. An integrated circuit is used to control the switching transistors. This IC not only controls the speed at which the transistors are switched, but also controls the amount of time that each transistor is energized. The output voltage of the power supply is determined by the

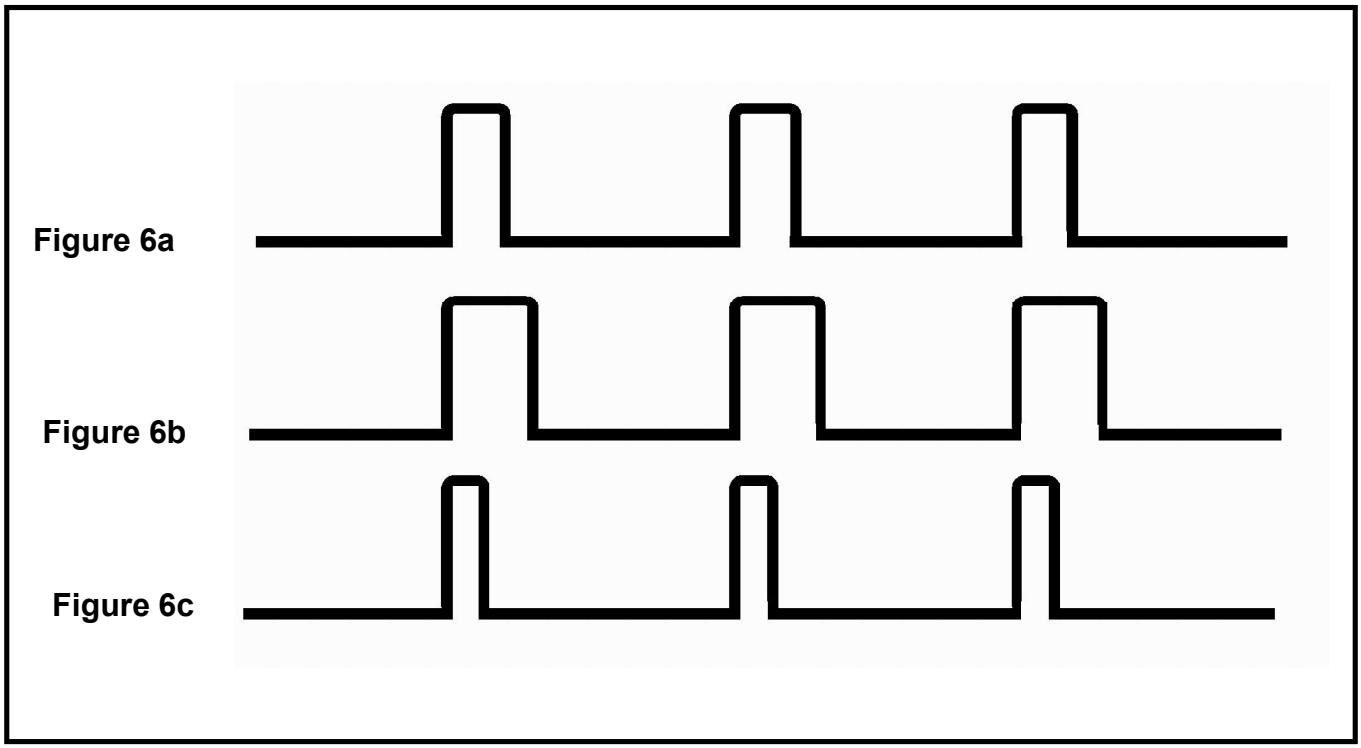
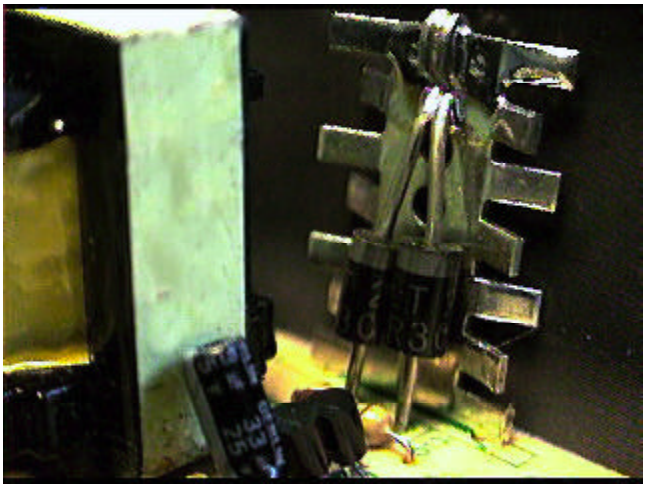


Figure 6a

Figure 6b

Figure 6c



In some power supplies, the output rectifiers may be in conventional diode packages, often with heatsinks.

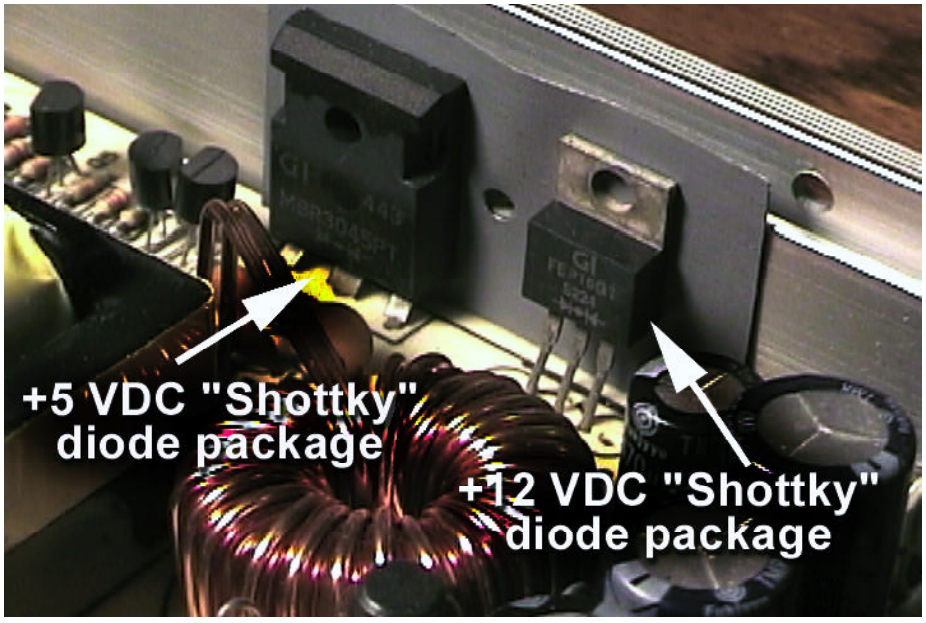
"on" time of the transistors. If the transistors are keep on for a longer period of time, the output voltage of the supply will rise, while shorter times lower the output voltage. This is known as "pulse-width modulation" or PWM.

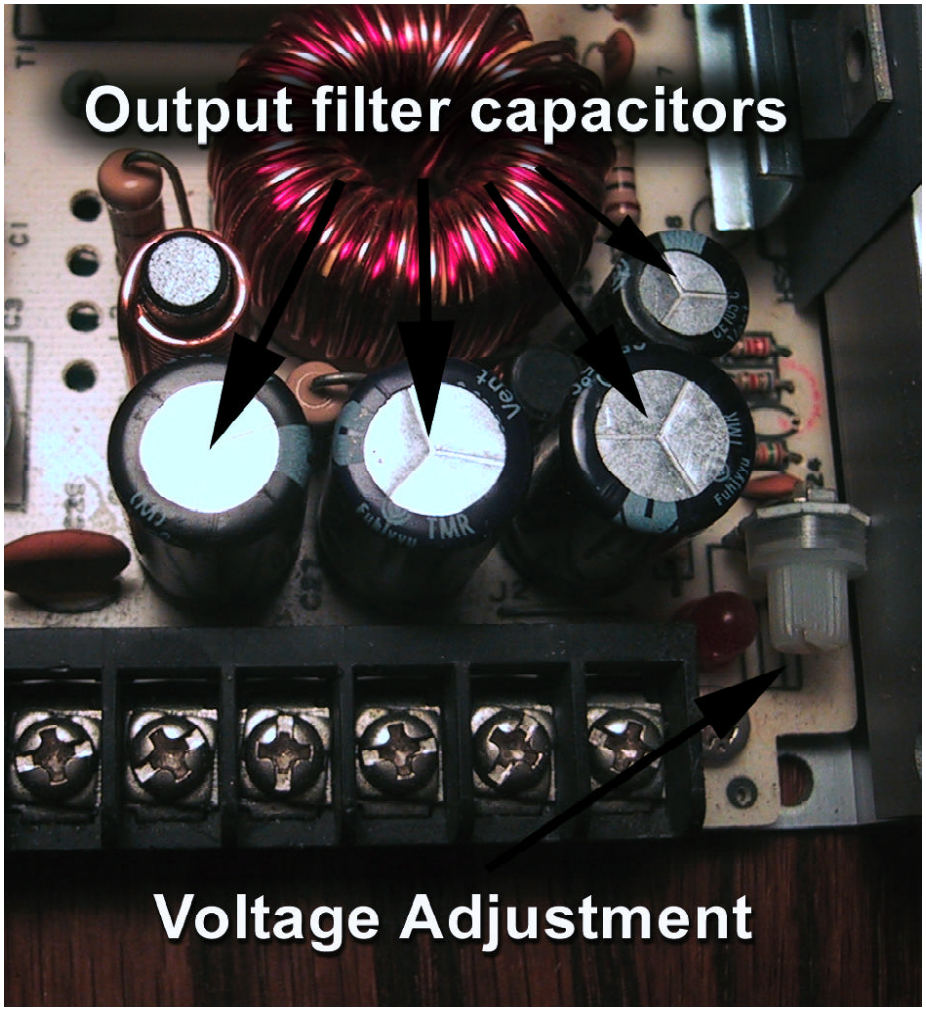
This is an important concept and it rates a bit more discussion here. Take a look at the graphs in figure 6. These are simple graphs that show *time* in the horizontal direction. The vertical axis represents the *"on" and "off"* times of the switching transistors. Figure 6a shows us a representation of the timing of the switching transistors when the output of the power supply is perfect (let's say, +5 VDC but it could be anything, of course). As long as the output voltage is exactly +5 VDC, the transistors remain on for just this exact amount of time each cycle, producing just enough magnetic flux in the transformer to produce an exact +5 VDC output.

The +5 volt output of the power supply is regulated by feeding some of the power supply's output back to the integrated circuit that controls the switching transistors. For the sake of discussion, let's say that the AC line voltage has dropped a bit, due to a big air conditioning unit coming on line. Naturally, if the primary voltage has dropped, the output voltage of the transformer would follow suit. However, the instant the voltage begins to drop, the IC detects the voltage drop through the feedback line and allows the transistors to remain energized for a longer period of time (see figure 6b). This raises the output voltage back up to where it should be at exactly +5 VDC.

Conversely, a rise in the AC line voltage would cause an output voltage that is too high. As before, this rise in voltage is instantly detected by the feedback line which signals the IC to cut back the transistors' "on" time (see figure 6c) lowering the output voltage.

The other cool thing here is strictly academic but interesting nonetheless. When a series-pass regulator "regulates" it does so by casting off excess energy as heat. The heat is caused by the IR drop across the junction of a transistor that is neither fully on nor fully off but rather is operating within its "linear" region, acting as a resistor. That's why they're referred to as "linear" power supplies. That is also why linear power supplies often require large heatsinks. Average efficiency for a linear power supply hovers around 60-65%. It really depends on the voltage difference between the unregulated input voltage and





the output voltage. The greater the difference, the less efficient it will be.

On the other hand, each of the switching transistors in a switching power supply is either completely off or totally on (a condition known as "saturation") and so it does not generate the type of heat due to IR drop that we see in a linear supply. This boosts efficiency to as high as 80-85%. It also allows a powerful power supply to be built in a small package due to the small, ferrite-core power transformer and the ability to use much less massive heat sinks.

The Outputs

The output of the power transformer is now high frequency, alternating current. It is then rectified by special high-speed diodes to change it to direct current. This output is not pure DC however, and requires extensive filtering to remove the high-frequency "noise" that is generated by the rapid switching action of the transistors. Filtering is accomplished by using a combination of coils (also known as "chokes") and capacitors.

The higher the output current, the larger the capacitors have to be. Typically, for the main +5 VDC, 12 amp output of a power supply, you might see a pair of output filter capacitors as high as 3300 or even 4700 microfarads each. On something like the -5 VDC output (which provides very little current, generally less than a couple of hundred milliamps) you may find as little as 1000 microfarads.

The coils will often be torroids. A torroidal choke has an interesting electrical property in that in addition to blocking any high-frequency ripple from the DC output of the supply, the torroid also acts as an energy storage device. A capacitor is an energy storage device as well but instead of storing energy through electric charges as it does in a capacitor, the torroid does it by storing magnetic flux in its core. The ring-shaped core traps the magnetic field so it can't escape. Think of it as a magnetic flywheel.

After passing through the output filter circuit, our pure, regulated DC is ready for use by the rest of the electronics in the machine. No further regulation is required because the PWM controller IC has instructed the power supply to produce the exact output required.

Next Month:
Part 2 - Troubleshooting

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Additionally, current and future articles more-or-less assume that readers are already familiar with what has been covered in past issues. This editorial policy assures that Slot Tech Magazine's contributing writers are not limited to "writing down" to the level of a novice technician but are free to continue to produce the most comprehensive technical articles in the gaming industry.

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- ☐ **August, 2001**
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