Slot Tech Magazine

Slot Machine Technology for the North American Gaming Industry

February 2010

Slot Machine Repair Tips
Power Supply Basics

$10.00

Slot Tech Magazine

The New Las Vegas Strip.

Command™ Strips for Touch Sensors

Quick Removal and Easy Integration

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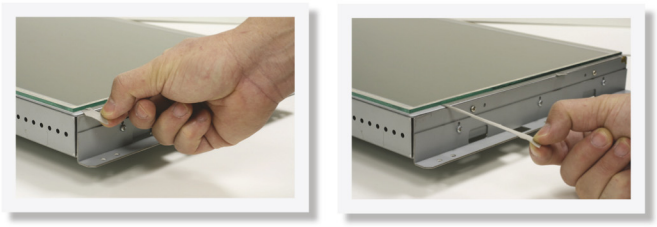

1 Pull Tab at 90 Degrees

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Using "peel and stick" Command Strips, a touch sensor can be easily integrated to a display in minutes and quickly put back into service.

1 Apply First Four Strips

2 Apply Next Four Strips

3 Mount The Touch Sensor

Watch Video

See how easy it is to use Command Strips for Touch Sensors to integrate sensors and to remove sensors at www.3m.com/touchstrips. Seeing is believing.

www.3m.com/touch

Command™ Strips

NOTICE: Command™ Strips for Touch Sensors were developed for use with the 3M™ MicroTouch™ System SCT3250EX (previously known as the 3M™ MicroTouch™ ClearTek™ II System). Customers must determine whether Command Strips are suitable for use with their particular touch sensor and in their intended application.

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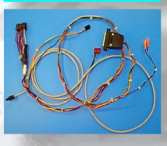

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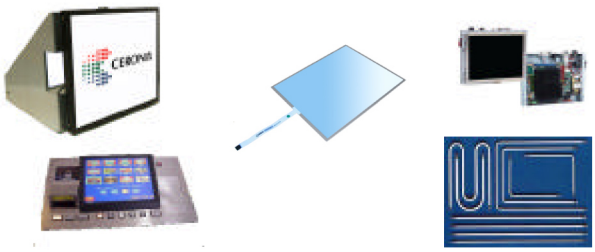

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February 2010

Randy Fromm

I really have nothing to say this month. Seriously.

Two hunters are out in the woods when one of them collapses. He doesn't seem to be breathing and his eyes are glazed. The other man pulls out his cell phone and calls emergency services.

He gasps to the operator: "My friend is dead! What can I do?"

The operator in a calm, soothing voice replies: "Take it easy. I can help. First, let's make sure he's dead." There is a silence, then a shot is heard.

Back on the phone, the hunter says, "OK, now what?"

Happy hunting. See you at the casino.

Randy Fromm

Randy Fromm - Publisher

Randy Fromm's
Slot Tech Magazine

Editor
Randy Fromm
Technical Writers
Scott Reynolds, Vic Fortenbach, Chuck Lentine, Kevin Noble, Herschel Peeler, Pat Porath, James Borg

Slot Tech Magazine is published monthly by
Slot Tech Magazine
1944 Falmouth Dr.
El Cajon, CA 92020-2827
tel.619.593.6131 fax.619.593.6132
e-mail editor@slot-techs.com
Visit the website at slot-techs.com

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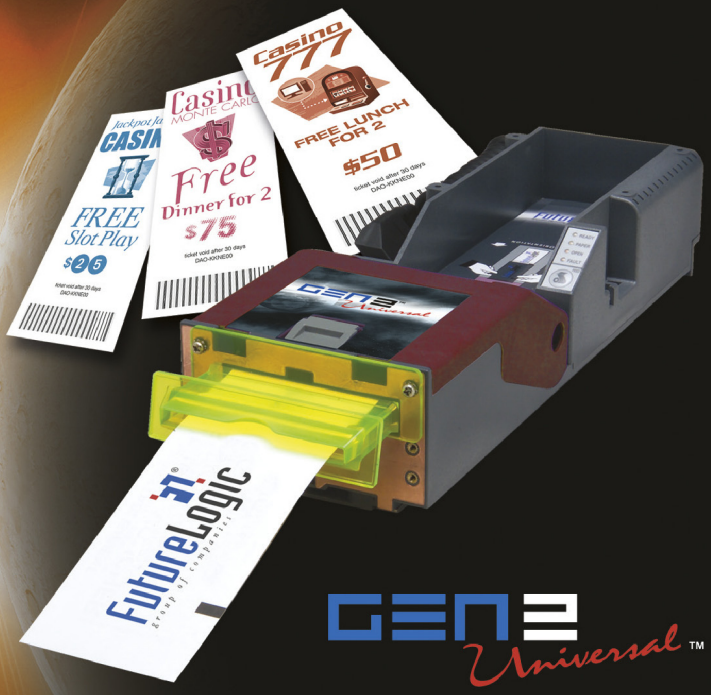
in gaming printers



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Doh!

By Kevin Noble

WMS Bluebird Reel Shows Printer Error and Reel Tilts

In the spring of 2009, I attended EZ Pay training in Burlington, Ontario to get trained on the EZ Pay system, equipment and troubleshooting. One of my classmates was Tim Robinson from Clinton Racetrack. Since the training, we have been in contact here and there to help shed light on some of his problems that he has encountered. This one day he chatted with me about this particular problem that was bothering him. He began by telling me some symptoms like the LEDs not displaying. They were unable to access diagnostics or options, the machine will not allow a RAM clear, the reels were dark and not spinning on reboot. I made a few suggestions that did not work. I asked Tim if the problem was ever solved and what he did to repair the problem.

They started by checking the wiring and connections, changed one at a time, changed the light matrix board, the printer, the reel driver board, the backplane board, the CPU, and the 24 volt power supply and the problem still existed.

Continuing on with the troubleshooting process they tried disconnecting wires going to Top Box, but no change. They unhooked various wire harness connections one at a time to see if what happened. Then, finally, as a last resort, they changed the wire harness. When the harness was reconnected, it came back up and they were able to RAM clear the machine and option the game. ACGO tested and placed it back in service.

"This is a short form write up of a weeks worth of all our techs going through various troubleshooting methods to get this game back in service" said Tim.

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#8610- Protective Mylar sheet W/ copper tape attached for 6.2" Hitachi LCD in **IGT NexGen**

#8570-6.2 inch Hitachi LCD #TX16D11VM2CAA with 4 wire touch screen for **IGT NexGen**

#8480-Single RAW cold cathode lamp for 10 inch LCD monitor in IGT games

#8920- Single RAW cold cathode lamp for 15 inch LCD monitor in IGT games

#9670- Single RAW cold cathode lamp for 15 inch LCD monitor in IGT games

#9290- Single RAW cold cathode lamp for 19 inch LCD monitor in IGT games

FOR BALLY GAMES

#8650- Single cold cathode lamp assembly for **Bally IView player tracking system** 6.2 inch "IDW" LCD

#8310 – 5 wire touch screen for **Bally IView** 6.2 inch Hitachi LCD

#8950- 5 wire touch screen for **Bally Iview** 6.2 inch "IDW" LCD

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Konami K1.5V Video 481 – CD ROM Read Error 940 – Self Diagnostic Boot Error

I was called to this game about a week ago for the 481 CD ROM errors and noticed nobody was playing the game. I reset the error by turning the tilt key and thought nothing of it until a week later. The same error message happened again so I decided to clean the CD and reset the error. About an hour later I was called to the same game for the exact same error. I noticed in the MEAL book that this was happening more and more frequently and that this started about a month before I got involved. This time I was going to change the CD ROM drive. I went back to the shop and discovered we had none in stock so I decided to use the one off the spare CPU in the shop. I swapped the units and found that the newer unit went into a 940 Boot error during boot up. The back up plan was to use the extra "extra" spare CPU in the shop and found that this unit kept rebooting itself. Reading the manual suggested that the CPU or main board could be the problem so I decided to try a new CPU. After having the seals broken, I changed the CPU and much to my surprise, the same rebooting process started again. I decide to go back to the original CD ROM unit because it was the least trouble it was causing. I inserted the EL Key into the slot and the game would jump right to the "Self Diagnostic Boot" error and not even give me the chance to clear the game or set options. Our AGCO officer recognized something on the screen [What?-ed.] and asked me to swap the two RAM chips on the boards and the game did allow me into the next process. The game was next RAM cleared and the options were set. I fired in my set of bills and cashed them out, recorded my meters. And the problem was solved, right? Wrong.

Konami K1.5V Video Will Accept Bills But Not Tickets

This is a continuation from the previously discussed problem. Just when I thought I had everything under control, I placed my ticket into the game and it spit it back out without any hesitation. I next swapped the BV head and transport with the game beside it but that did not work either. I cleaned and calibrated the BV head. I opened the door, verified my options, (as far as I knew they were correct) and tried to re-insert my ticket. It still would not accept. I asked Chris to go into the CVT room and remove all the errors off the CVT, which he did, with the same results. We tried the force download. Same. We swapped power supplies with the game beside it. Same. We watched a Patron insert a ticket in a game two machines down. When she left, we borrowed her BV head and assembly with the same results. Now I was really starting to doubt my options again. I opened the door, verified the options, the BV was set to JCM WBA, the poll number was correct, the ticket limit was correct, all other options were correct. I closed the door, inserted my ticket and it spit it back out. Now I was getting frustrated to the point where I tried to hand back my ticket to the Cage and tried to wipe my hands of the situation. After a short break, I decide to start all over.

The funny thing about the whole situation was that I had mentioned a long time ago that I should just go to the shop and get a new BV head and transport. I finally broke down because we placed different tickets from other machines and different CVTs into the game to see if it would accept. Everywhere, but my game. I took the BV head and transport to the shop, took out a new transport and shifted through the entire BV heads for nice clear (not foggy) optics. I brought the new BV assembly to the game, inserted my ticket and the son of a bitch accepted it. I could have saved myself some time and aggravation only if I would have listened to myself in the first place.

Bob Yabroff
President

"I have always supported Slot Tech Magazine"

"But to tell you the truth, the content of this magazine is gobbledygook to a seating guy like me."

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Bally S6000
91-0 codes

I was called to this machine for the 91-0 code when I noticed that once a week, this error code would pop up. Powering off the driver board would clear the 91-0 code that seemed to solve the problem at the time. The once a week turned into every couple of days according to the MEAL book entries and it was time repair the problem as I was called to this game about two weeks later. At first, since resetting the power supply was the fix, we began by replacing the Mikohn power supply. We could not really tell if this solved the problem until a couple of days passed when, as usual, it returned. We next swapped out the driver board but same problem continued. We noticed that the harness from the motherboard to the driver board had been cut and frayed so we replaced the harness but the same problem came back after a couple of days. Next we tried our second driver board but this time the game lasted a couple of hours. We decided to go ahead and change out the MPU board just to rule out the possibility. A few hours later, the 91-0 code reared its ugly head yet again. After scratching our heads over this one we decided to try our last driver board in stock to see if we get this game up and running. We changed out the driver board and waited. This time hours have passed and the game lasted throughout the night. We checked on the game the next morning and we discovered the game went into an 83F code. We soldered on a new battery, re-cleared the game and set the options. So far it has been without any problems but we still have our fingers crossed.

Aristocrat Manual JPs

I was asked to take a look at this one game that kept going into manual jackpots. The Slot Supervisor advised me that she placed the game out of service until I was available to look at this game. When I get to the game, I usually verify the Mikohn and soft meter are matching. This tells me that the game and the SPCII board are talking to each other. I checked the Gamma in diagnostics mode and found that this was also communicating. I cleared the SCPII board and noticed the "Host Disabled" error now appeared on the game that was not there before. I re-cleared the SPCII and rebooted the SMIB at the same time but the code remained. Just to make sure I was not missing something, I went to the shop, signed out a new SPCII board and placed it in the game. The problem still existed. My next step was to verify the game was communicating with the CVT so I went into the CVT room and generated a status report. The report said that the game was responding. The CVT started to beep once I pressed the "REPORT" button. (It should have started to beep once I logged into the CVT which I thought was weird) and I noticed that there were "Machine options were changed" errors that I had to clear. I cleared the errors twice and in about a minute, the errors returned. The CVT started that annoying beeping again with the same "Machine Options changed" error. I re-cleared the errors, waited about two minutes before I proceeded and nothing happened. I got out of the room and proceeded to the machine to check on the status and noticed from a distance that the BV light were flashing ready to accept any bills or tickets.

Bally Alpha
Battery Change Information

FYI, we just had our first low battery tilt with this platform. We replaced the two batteries one at a time but it now won't complete its reboot. Called Bally and they told me you have to replace them one at a time but you also have to reboot after each one. Ours now requires a RAM clear so hopefully this will prevent anyone else from having the same problem. We have also experienced this problem recently when we were removing our CPU for

Subject: TechFest 20
Date of Event: May 4-6, 2010
Location: Mystic Lake Casino Hotel

Schedule of Events

Events subject to change

Tuesday, May 4, 2010
9:00 am - 12:00pm
Power Supply Repair - Presented by Randy Fromm - Let's face it, we have a lot of power supply failures in slot machines. Some power supplies are more-or-less disposible due to their cheap replacement cost but many of the supplies we find in slot machines are custom-built units costing hundreds of dollars. For example, the ability to repair Aristocrat and IGT power supplies (actually manufactured by Setec and Win-Tact respectively) in-house will save your casino hundreds or even thousands of dollars in a year. We will cover the operation and repair of power supplies in detail during this session.

1:15pm - 3:15pm MEI - BV troubleshooting and repair - Suzo-Happ's Director of Training and Service David Oldham will discuss BV operation and service. Troubleshooting guides and handouts will be presented to help speed through troubleshooting in the shop.

3:30pm - 5:30pm FutureLogic Ticket Printers - Suzo-Happ's Director of Training and Service David Oldham will discuss FutureLogic printer operation and service.

Wednesday, May 5, 2010
9:00 am - 12:00pm CRT & LCD Monitor Repair - Presented by Randy Fromm - Video slot monitors are a lot easier to fix once you know how they work. Some understanding of electronic components will be helpful as this session will be somewhat more advanced than at previous TechFests.

1:15pm - 3:15pm 3M Touchsystems Touch Screens - Touchscreen Technology Presented by Paul Hatin and Mark Roberts - 3M Touch Systems Field Application Engineers - It is really amazing how touchscreens actually operate. During this session, touchscreen theory of operation will be presented along with diagnostic and repair techniques.

3:30pm - 5:30pm Incredible Technologies Slot Machines - Incredible Technologies has been credited by many operators as one of the most important and innovative manufacturers of video games in the world. Their "Golden Tee Golf" game revolutionized the online game tournament. Now, IT brings their team of manufacturing and design experts to the casino industry and to TechFest 20 with a close look at their IT slot machine. You will not want to miss this presentation.

Thursday, May 6, 2010
9:00 am - 12:00pm Ceronix CRT and LCD Monitor Repair - Presented by Troy Nofziger - Ceronix
Armed with a general knowledge of how monitors work (and how to fix them when they don't) it's time to look at Ceronix. The Ceronix design is unique in the entire world and requires a bit of specialized knowledge in order to be successful at repair. LCD Monitor repair will also be covered. Ceronix's most experienced bench tech, Troy Nofziger will instruct.

1:15pm - 3:15pm Transact Technologies Ticket Printers - Transact Technologies' Russ Wigé presents servicing and troubleshooting Transact brand, thermal ticket printers. These units are simple to understand and troubleshoot, once you know how they're put together.

3:30pm - 5:30pm JCM Bill Validators - This is arguably the best seminar of its kind in the gaming industry so we've saved the best for last. This presentation will be given by JCM's Jack Geller. This is your chance to ask the world's #1 expert about your JCM "issues."

To sign up for TechFest 20, visit the website at Slot-Techs.com
Earlybird tuition is $495 per person before March 4, 2010

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AGCO inspection. As a precaution now we have started to swap out the old batteries and replace them with new ones while doing the 326 Operating System upgrades.

Thanks to Jamie Tarzwell for posting this information regarding the Bally Alpha CPU battery change. It has saved us time, many un-necessary RAM clears and AGCO reseals.

Atronic e-motion "Cash Fever" APL Error

Sometime during the night, a scheduled power outage was planned to test the generator. That usually spells trouble at our site. When we arrived in the morning and were told about the power outage, we knew that we would be resetting between 30 and 40 games. Some games had simple solutions by simply rebooting the game but others needed a little bit of troubleshooting. We had our fair share of flickering lights and starters that needed replacing. We had to replace a number of IGT S2000 power supplies with the Netplex waiting messages and this one e-motion with the APL error. At first we checked the CVT to see if there was any error that we needed to clear off. We rebooted the game to see if it would come back but the same error was displayed. We performed first the COMM board clear and then replaced the COMM board itself and the game released the APL error and held onto the "JP was changed-RAM cleared is needed" message. We had the seals broken on the game, RAM cleared the game and the thermometer on the "Cash Fever" came to life displaying the progressive values. The game was placed back in service.

- Kevin Noble
knoble@slot-techs.com

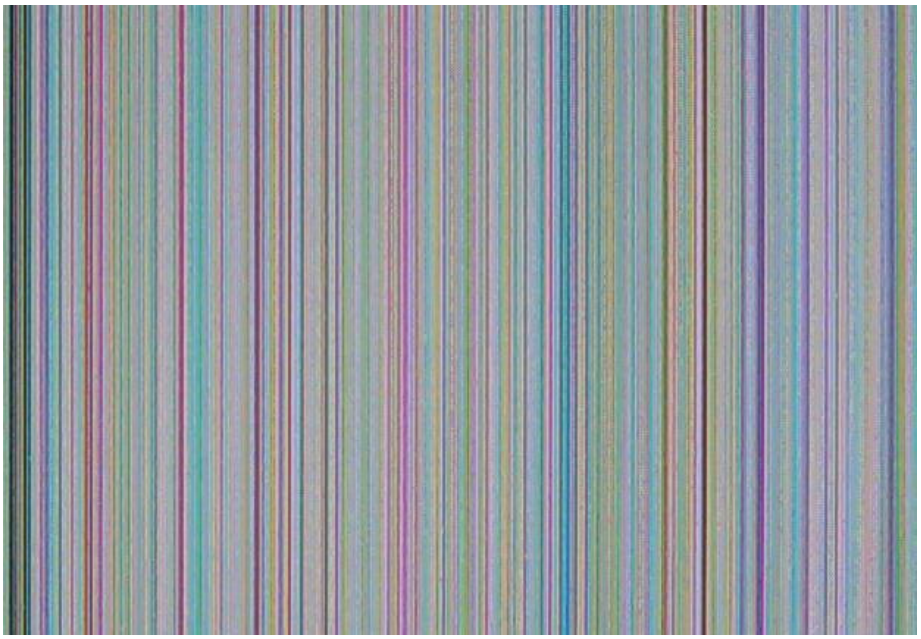
Slot Tech Update

Kortek LCD Monitor Repair Update

This from Jeff, one of our readers, via the Slot Tech Forum:

In my troubleshooting of the Kortek KTL190ST PCB I have found that Chuck Lentine article in the Slot Tech Magazine for blinking LCD monitor is correct but I have also seen other problems where the image will be scrambled without any video image on the LCD (see photo).

I have been finding that C703 a 2.2mfd 50v Surface mount cap has been testing bad. I have been able to repair the video problem by replacing this cap.



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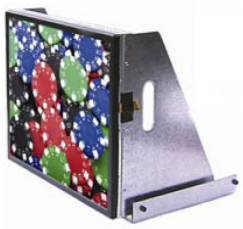

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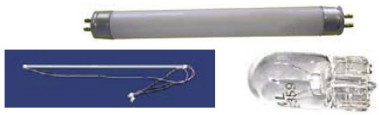

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Quick & Simple Repairs #59

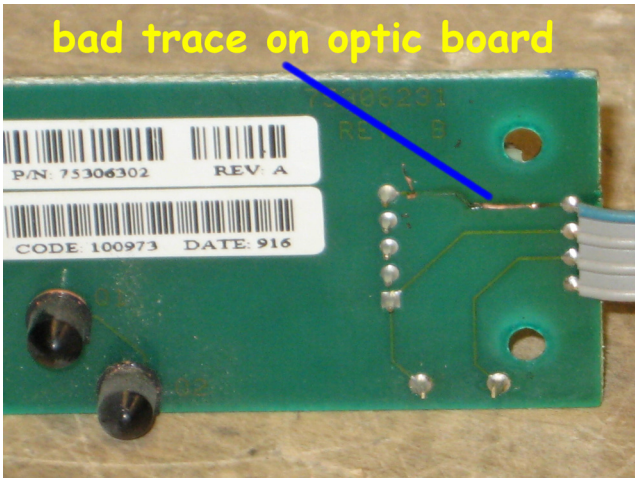
By Pat Porath

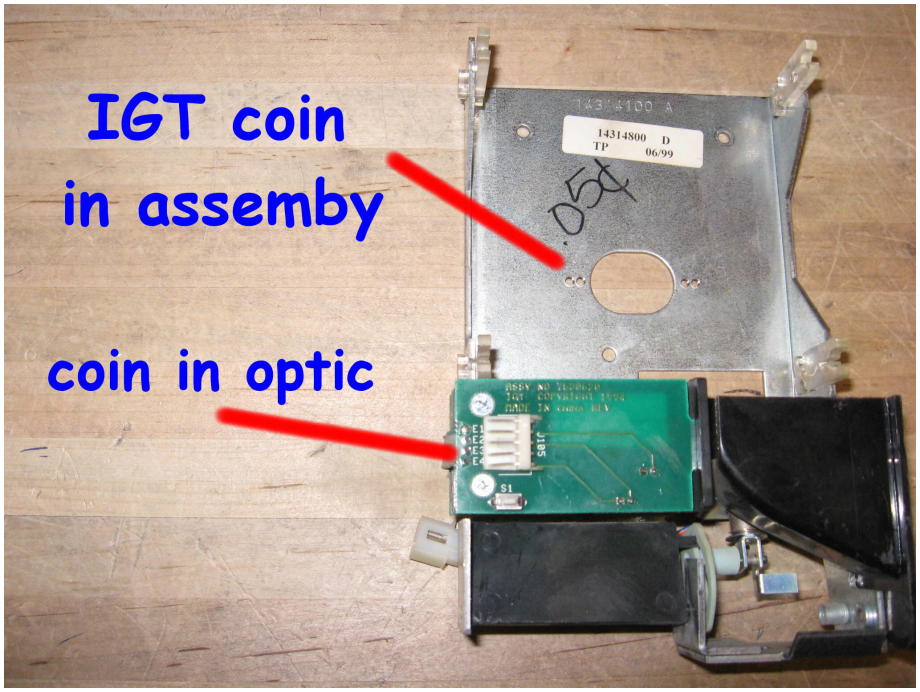
IGT Game King "Coin In Error"

First of all, how can you have a "coin in error" when the majority of games on the floor today don't even use coins anymore? At the casino where I work (which currently has 1428 games) still has some coin games. I would guess around 50 or so, a few "classic" quarter games, a few nickel games and some dollar token games. Anyway, this particular multi-game poker machine had a "coin in error" that absolutely would not clear. A lot of the time when you see this on an IGT (either a video game or an S2000 reel game) one of the I/O cards in the main slot door is loose or bad. After 15 years working on slots, there have been quite a few times when I have received a call for a "coin in error" on an IGT that is in fact, a total coinless game; one of the two I/O cards in the main slot door was loose and had become disconnected.

If you come upon an I/O card in an IGT that is loose, BE SURE to power down the game BEFORE seating the card. If the card is seated "hot" (while the game power is on) there is a very good chance that the board will be bad once inserted.

Back to the Game King coin in error. Both of the I/O cards in the main slot door were snug and in place. I thought that this was interesting, now what could the deal be? Power was turned off to the game and all off the boards were reseated, including both I/O cards in





the main door, the processor board and the I/O board that is located in the game. After that was complete, the game power was turned back on and when the slot door was closed once again. The coin in error still appeared.

Ok, now what? How about a partial RAM clear? Maybe somehow somewhere the game RAM got corrupt? I swapped RAM chips with their original sockets and ended up with a RAM error, which is what I had intended to happen. There are two RAM chips, I swapped them with their original sockets, placing chip A into socket B and chip B into socket A. After a partial RAM clear was initiated and cleared, along with the game options set correctly, I still had the coin in error.

Just a reminder, the game is COINLESS! How can it even have a coin in error when the game doesn't even accept coins or payout coins? I later found out what the deal was. What if in fact the game did actually have a coin in optic problem? Does the game need to have a functional coin in assembly? As I later found out, it does. I swapped (got to love swaptronics) the whole coin-in assembly with the game next door. Once the power was turned on and the game fully booted up, the error went away on the problem game AND the coin in error appeared on the "test game."
What did this tell me? A possible coin -in optic problem and that the specific game that I was working on needed the coin-in assembly to be functioning correctly. FINALLY the problem has been found, a faulty coin in assembly. I headed to the shop and grabbed a perfect spare. After it was put into the game and power was turned back on the error went away. Finally the game was back online.

What was the deal with the original coin in assembly? I had a bit of free time to take apart the assembly just to see what was going on. I would have guessed that the coin in optics were dirty and only needed to be cleaned. Come to find out that the coin-in optic board looked like a trace had over heated. As you can see in the picture, the trace on the coin in optic circuit board was in fact bad, causing the coin-in error. With a replacement coin-in optic board installed, the coin-in optic assembly was repaired.

WMS 550 Slant Top Video Problem

While making a round on the gaming floor, I noticed an older WMS 550 slant top was shut off. Why was it down? I should have read our tech log book right away in the morning, but I hadn't. Also I didn't see anything written on the "game card" (a.k.a. meal card). So I turned on the machine to see what the deal was. When you first turn on an older WMS game you are suppose to hear a "bong" type sound. This usually signals that the game memory and such are ok, then the game will

more than likely come up. This time when the power was turned on, no "bong" along with absolutely no video; the monitor was totally black. Since I didn't get the "bong" sound and "door open beeps" I guessed it may be a software problem. The game and the game next door were turned off. The main processor board was removed from the problem game and the known good board from the game next door was put into the problem game. When the power was turned on something interesting appeared on the screen. It showed something like "press diagnostic button to clear error." This indicated a possible bad main board but there was another problem. The monitor color was very blue, almost like the red and green guns in the CRT assembly weren't working at all. Well, one thing at a time. I grabbed a spare processor board from the shelf, installed it in the game, optioned it and such but still had a very blue screen. The original main processor board was indeed bad. Now that the game software was ok, it was time to replace the monitor with a spare. I grabbed a replacement and put it into the game. Finally, when the power was turned on this time everything was OK. The original monitor had a problem too. With a replacement main processor board, optioning the game, along with the monitor replacement, the game was back online.

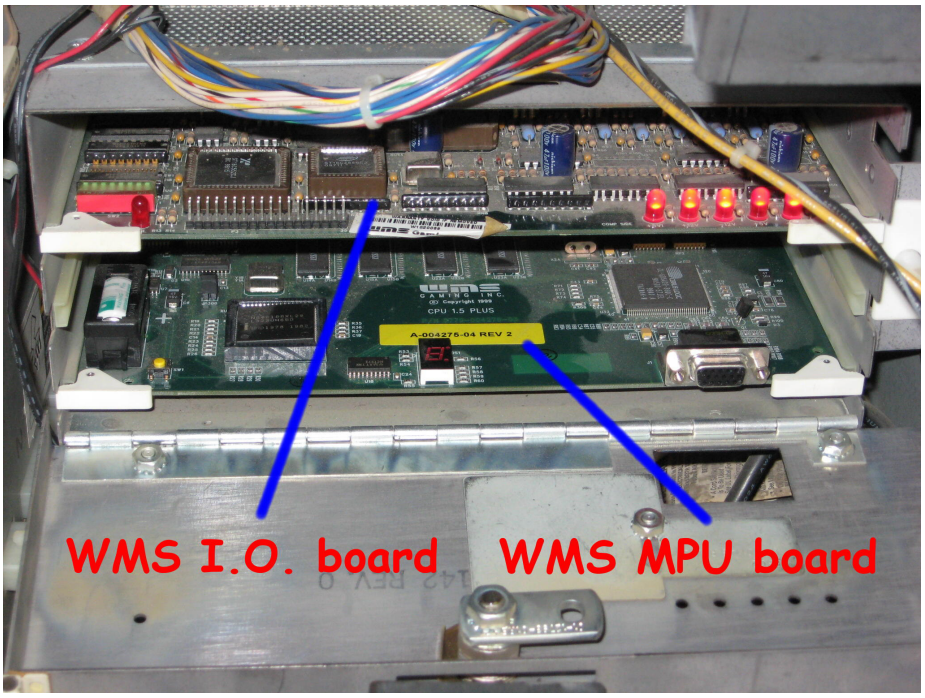
Aristocrat "No Signal" Error on Monitor

While looking at an Aristocrat "Delta Belle" game, a "no signal" error was on the monitor. I reseated the main processor board and the I/O board but the error remained. Maybe it is a processor board problem? The board was swapped with the identical program. As soon as the power was turned on, the game started booting up. It looked like the board was the problem.

Off to the shop I went to grab a replacement. The chips were removed from the original and put onto the replacement and the board was put into the game. When power was turned on, the "no signal" error appeared again. Now what? A possible bad board right from the shelf? A different board was grabbed off the shelf, the chips put onto it and that one was put into the game. Once again, "no signal."

What in the world was going on? In my opinion, the way it looked to me was that the game software may be corrupt. Logically thinking, a known good board was tried in the game and the game worked. Two replacement boards were tried with the original game software and they didn't work. That leans toward the thought of bad software. I asked if the chips could be verified with the Kobetron and they were. A bit later in the day I was told that the chips were fine. WHAT? How could the chips be fine? I would have lost my bet on that one. I was almost sure that one would be bad.

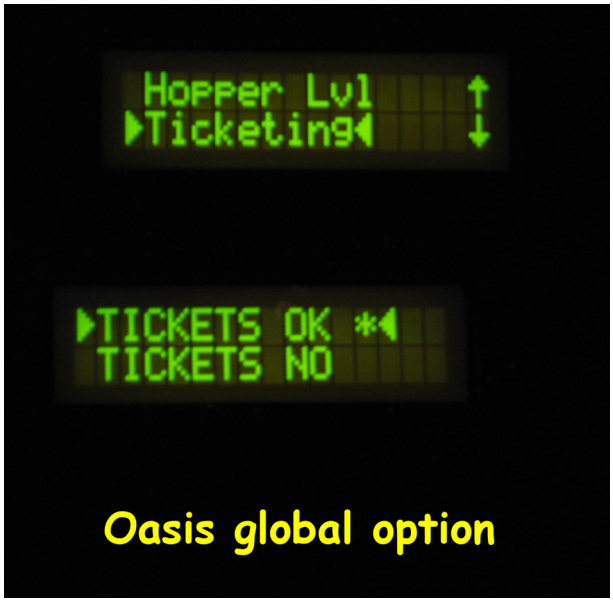
Not exactly sure what to swap or replace next, some help was needed. The situation was explained and an idea was concluded. How about putting the original processor board back into the game to see what happens? You know the deal when a bill acceptor won't work and it is swapped with the game next door, then BOTH work? A similar thing here. When the original board was put back into the game the darn thing started booting up. No doubt this was an FM repair (freaking magic) repair. The



game was fine now but questions still remained. Why wouldn't both spare processor boards work in that game? When looking at them quickly, they looked the same as the original. Could both boards be bad? Doubtful but possible. I wanted a logical explanation why. As techs we don't always get a reason to "why" but I wanted to give it a whirl anyway. As I later found out, the boards, when quickly looking at them, looked similar but were a bit different. A couple of components were different along with a totally different assembly number. A main processor board with assembly number 410557 will NOT work in a Delta Belle game. Assembly number 410541 did. What an ordeal.

IGT AVP Bar Top "Protocol Error"

After setting up and testing ten bar top games, one of them was locking up for hand pays and had a "protocol error" when the door was opened. My personal first thought was that somewhere a game option was incorrect. A co-worker asked what was going on so I told him what the bar top game was doing. We took a look at the game. He said a few times that it was a "system error" which would be an "Oasis tracking system" problem. I still thought that the problem was a game option. While checking the options, once again he stated "system" and I said "option" because so far all of them looked ok. Finally after all options were checked, such as "validation enhanced", SAS channel 3, address 1, printer enabled, all were OK and it almost had to be a "system" problem. Once again I was wrong. Even though I "globaled" the Sentinels ("Global" means to use a specific card in the card reader to see and select settings for the Sentinel. When setting up new games it is used to "key-in" the location of the game, communication type such as IGT and SAS and check other Oasis options.) So I inserted my "global card" and started going though the settings. Toward the last part of the options, an incorrect setting was found. During my 15 years of working on slots I have never seen this before. The "ticketing" option was set at "TICKETS NO." This wasn't correct, all of our games are set as "TICKETS OK." How did this get changed? Within seconds after changing it to "TICKETS OK" the protocol error on the screen disappeared. My co-worker was absolutely correct and the game was be fine. Just to make sure, I tested it and it did in fact print out and accept tickets.



- Pat Porath
pporath@slot-techs.com

Power Supply Basics

By James Borg

Any piece of electrical equipment, no matter how simple or how complicated it might be, has to have something in particular to for it to operate, for it to come alive. Without it, the equipment is dead, lifeless or even kaput. For it to operate, it is an absolute must to have some sort of power supply injected into it. This might be an external power supply unit or an integrated part of the equipment itself, like in the case of a monitor. It might even be just a battery, as after all, this is a source of power in itself. This depends on the design of the equipment, its function and also on its overall cost.

We've all come across power supplies of some sort during the course of our existence. Some would be taken for granted as they are everyday objects, but they still would be classified as power supplies. A typical case would be a mobile telephone charger. This is in actual fact a power supply unit which charges up the batteries in the phone. We also have power supply units which give life to notebooks or laptops, while at the same time charge up their batteries as well. These supplies would be regulated and they would have something in the order of 5 Amps available, which is no joke. One which is overlooked a great deal is the door bell power supply unit. This is perhaps the simplest of the lot, as most times all it is, is a step-down 'bell' transformer from the grid voltage down to typically 12v alternating at the mains frequency. It still however supplies the juice to the solenoid in order to activate the bell's plunger and without this form of power, there won't be a noise to be heard when a visitor decides to drop in at the front door and pushes the bell button. Unless of course he decides to knock in the first place, in which case, what you've just read about the solenoid and the plunger wouldn't hold too much ground, but still it's good to know about. I suppose he could also transport himself into your living room…but that's going a bit too far…but thinking about it, that would involve A LOT of power…so we're still on track here.

Another type of supply, or as they are commonly known, are AC adaptors. These are inserted directly into a mains outlet and their output is at the end of a lead having several types of different plugs to connect to various forms of equipment. These adaptors can be variable and have switch settings ranging typically from 4.5v to 12v dc. The rated current on

these is low and normally it won't be more than 1 Amp. These types of adaptors are usually pretty crude and most of them would have no form of regulation circuitry. Typically, these would consist of a step down transformer, rectifier diodes and capacitors for filtering the output, but that's all about there is to it. They work, and they can take some punishment, but not recommended to be plugged in to very expensive equipment.

There are also the types of supplies that we normally find in a home or office computer system. For their size, these units can pack a punch with DC currents reaching very high outputs. Some gaming machines use similar types of power supplies, but have various modifications incorporated. These usually consist of another output which would be rated at 24V. Normally this would power up specific sections of the machine such as the hopper or even motors, to have parts of the machine's cabinet in actual motion.

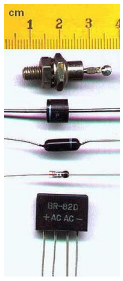
There are many different cases and forms of power supplies, some substantially more complex than others, but one can say that they all have one thing in common. Their main function is to convert alternating voltage, AC, from the mains, into continuous voltage, or DC, used by electronic components, excluding the bell transformer, for example, mentioned earlier as there is no DC involved in this case. One has to bear in mind that there are power supplies that convert from DC to AC, from AC to AC, or even from DC to DC, but these aren't really what will be discussed here.

There are basically two types of power supply designs. These are linear and switched mode. The resultant output will be the same in both cases, but the actual process of reaching this varies considerably in parts, design, efficiency, size and obviously the cost involved.

Linear power supplies are simple, familiar and very easy to repair. They are known to be relatively noise-free and reasonably reliable. An advantage with this type of supply is that they are easily to design and 'inexpensive' to manufacture. One major consideration is mainly on the amount of current

required to supply the equipment it's designed to feed. The greater the current required, the greater the size of the transformer. These types of supplies are usually approximately only 50% efficient, which is a great disadvantage on consumption costs in the long run.

A linear power supply is fed 220 V or 110 V from the mains, and it's reduced to a lower voltage by means of a transformer. The transformer converts the voltage available on the primary side to the required voltage level on the secondary side. Energy is transferred from the primary to the secondary side by the continuous build up and collapse of a magnetic field. The alternating current passing through the primary winding generates this field, which is then transferred as energy (electromotive force, or EMF), to the secondary winding. The voltage generated on the secondary side is proportional to the ratio of the number of turns of wire between the primary and the secondary winding. In other words, if this ratio is 10:1, and the input is 120v, then the output would be 12v. The windings normally consist of enamel coated, and hence insulated, copper wire. These are wound round a core which is made from a ferrous material, such as iron or ferrite. A great deal of work during the design is carried out on a transformer. This includes the input and output voltages and currents, the core cross-sectional area, insulating materials and physical size. Temperature rise caused by core and wire losses, which might render the transformer unsafe, also has to be taken into account. The output will vary according to the specified voltage of the equipment it's planned to be connected to. Typically, 12 V is used in many cases.

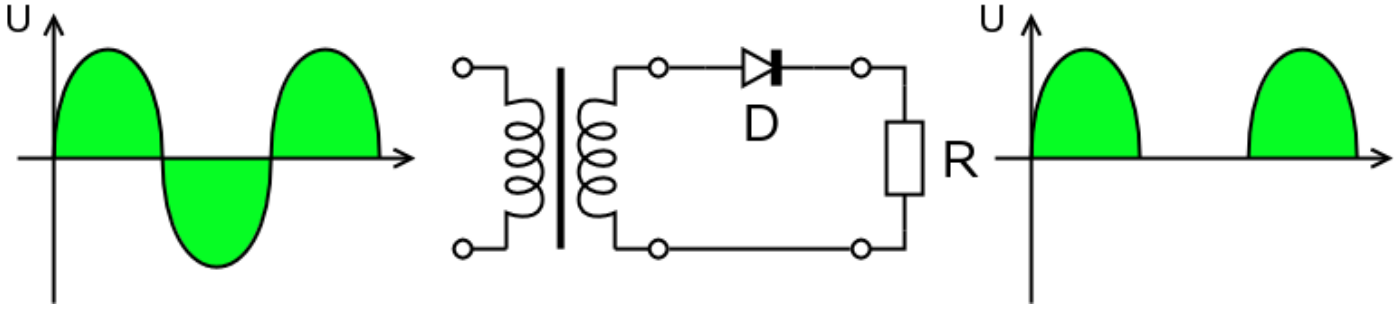


This alternating voltage is then passed through a diode or a series of diodes, and then filtered by means of an electrolytic capacitor, to finish off with a DC output.

The process where AC is turned to DC is known as rectification. A device that may be used for rectification is a diode. There are various types of diodes and these go back quite a few years. Early diodes used on radio receivers to rectify signals were made of a fine wire pressing on a crystal of galena (lead sulfide). Many years have passed now, and along the way, diodes developed from silicon were gradually developed, and are still in use nowadays. Silicon diodes have largely replaced selenium and germanium types of diodes. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than with only just one diode.

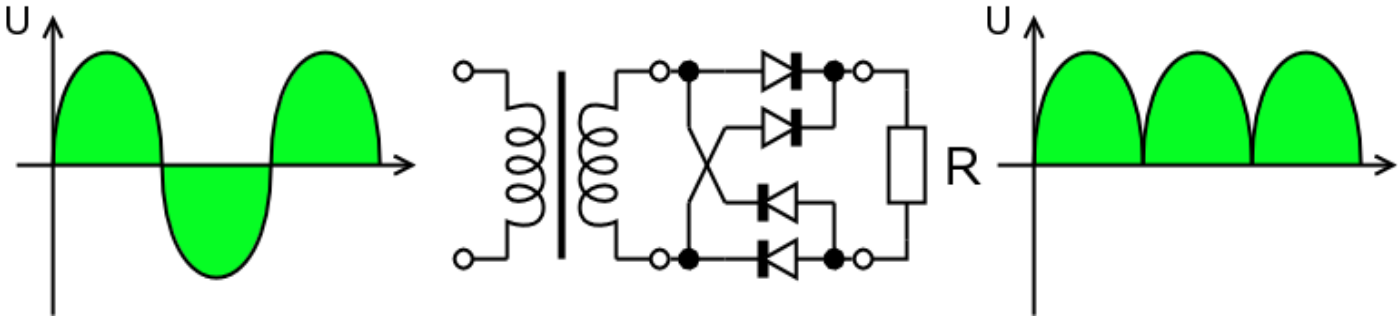
Rectification of the AC is carried out differently, depending on the configuration of the diodes and the type of transformer used in the process.

The most basic is HALF-WAVE RECTIFICATION where just one diode, D, is used on the secondary winding and feeds the load, R (see figure below).



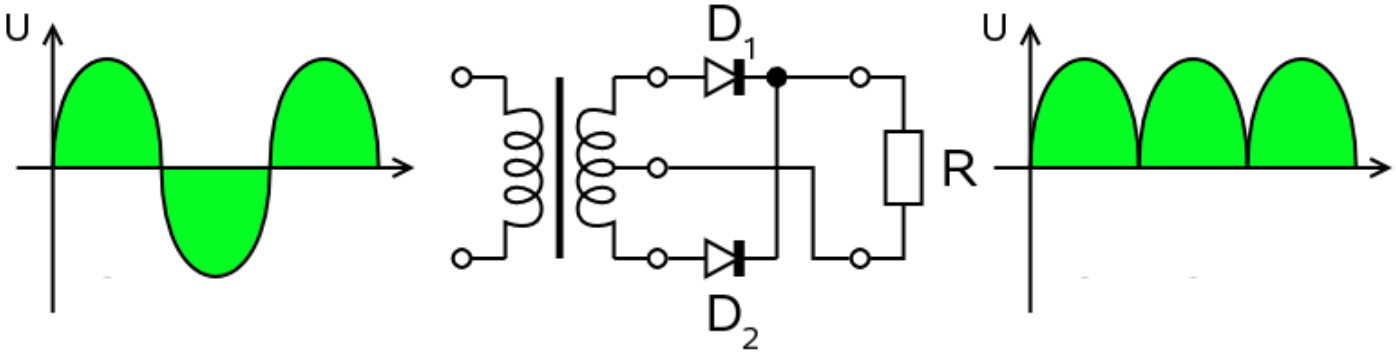
In this type of rectification, only one half of the AC waveform is passed, while the other half is blocked. The rectified output will be either positive or negative, depending on the orientation of the diode in the circuit.

In this configuration, the PEAK voltage can be calculated by multiplying the RMS voltage by the square root of 2, or 1.414. The RMS Voltage (dc) can be calculated by multiplying the PEAK voltage by .707.

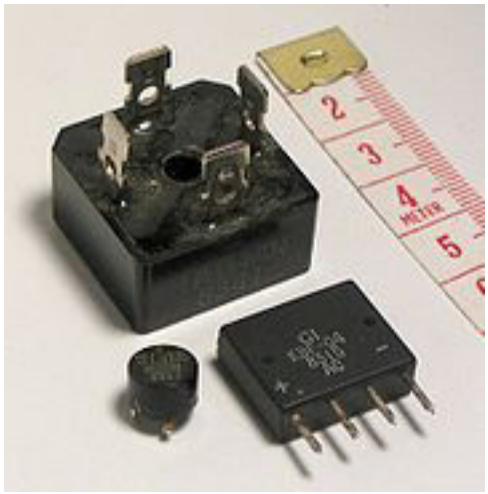


In FULL-WAVE RECTIFICATION (see figure above), the whole of the input AC waveform is rectified to one constant polarity, be it positive or negative, at its output. During this type of rectification, since both the polarities of the AC input are converted, this is more efficient.

Four diodes are required instead of the one needed for half-wave rectification. Four diodes arranged in this way are called a bridge, or bridge rectifier.



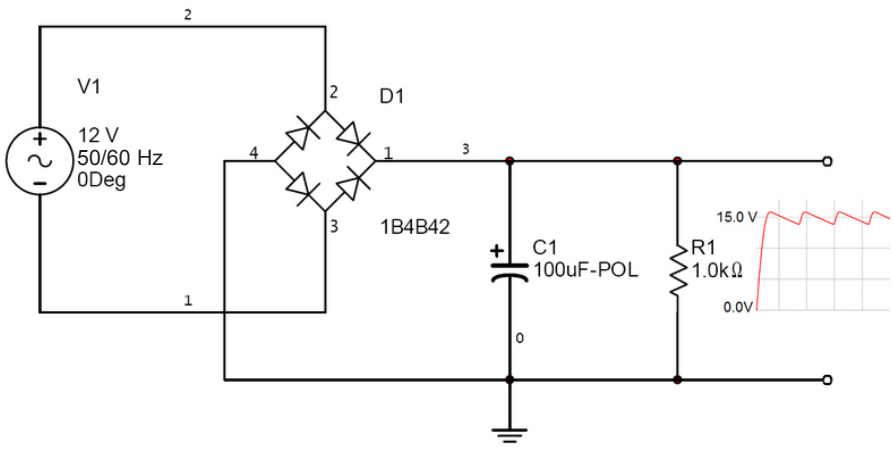
In some applications, a centre tapped transformer and two diodes are used for full wave rectification. Two diodes are configured back-to-back, that is anode to anode or cathode to cathode. Twice as many windings are required on the transformer secondary to obtain the same output voltage compared to the bridge rectifier above. In this full wave centre tapped configuration, only one-half of the transformer winding is used at a time.



The principle advantage of a bridge rectifier is that you do not need a centre tap on the secondary of the transformer. The bridge is a single package with four terminals protruding from it. One would be the positive, one would be the negative, and two would be the AC side of things.

Alternatively, four separate diodes can be used and these can be 1N4007 which is a 1KV 1Amp rectifier. Sometimes a bleeder resistor is used across the

electrolytic capacitor. The voltage at this stage of the process isn't smooth and it would be pulsating at the mains frequency.



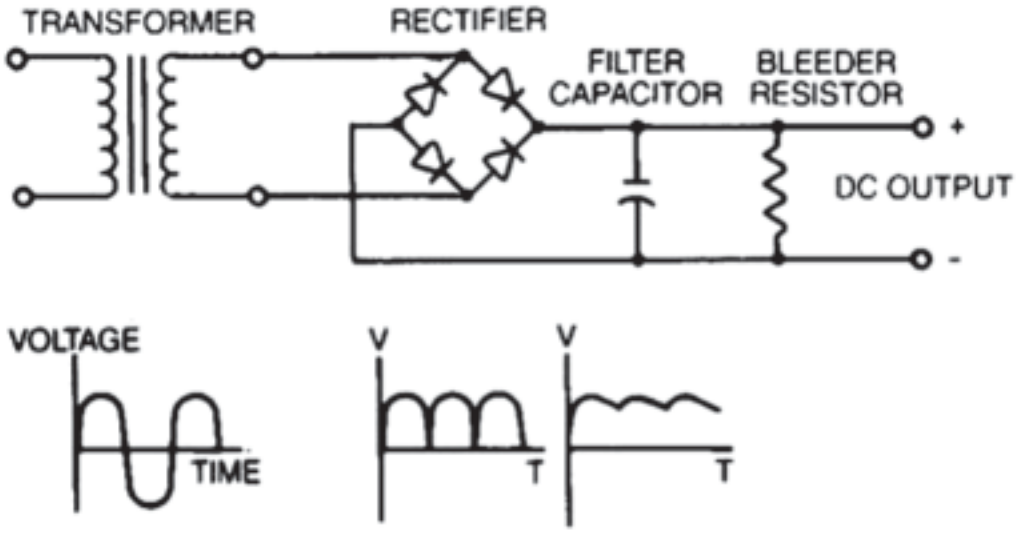
These pulsations are known as 'ripple'. Having this ripple present, the output isn't all that brilliant, so ideally, some form of regulation is introduced to overcome this.

Before we go into regulation, just what is a ripple in actual fact? A ripple, in electricity, is the small unwanted residual periodic variation of the direct current output of a power supply which has been derived from an alternating current source. This is due to the incomplete suppression of the alternating waveform within the power supply. In not so many words, this ripple is considered to be an unwanted effect, and its existence can upset some circuitry beyond imagination. Some practical examples are described here:

The ripple frequency and its harmonics can be heard on audio equipment, or radio receivers. This is because the unwanted pulsations are within the audio band. The ripple frequency can also interfere with analogue TV receivers. In this case, the screen might exhibit a pattern of moving wavy lines if too much ripple is present. This unwanted voltage can also reduce the resolution of electronic test and measurement equipment. On a 'scope, it will manifest itself as a visible pattern on the screen. Where digital circuits are concerned, this reduces the threshold, as does any form of supply rail noise, at which logic circuits give incorrect outputs and data can easily be corrupted.

To minimize this ripple effect on the output, a smoothing circuit or some sort of filtering is required. In its simplest form this can be just a reservoir or smoothing capacitor. Some refer to this component as a filter capacitor, and this is placed at the output of the rectified voltage. However, there will still remain some form of AC ripple voltage as the voltage still isn't smoothed completely.

One can use a large capacitor to help with the reduction of this ripple, but the greater the size of the



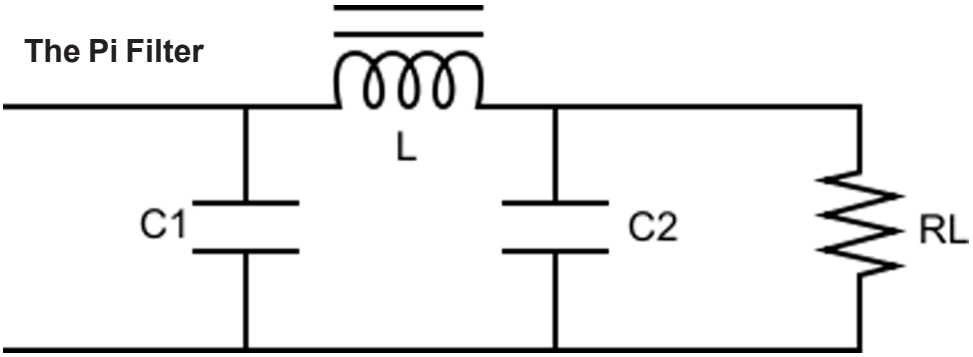
capacitor, the more the cost. This will also create high peak currents in the transformer's secondary winding and in the supply feeding it. Depending on what the supply's output will feed, a ripple of a certain magnitude can be tolerated. The capacitor in this situation has to be of a size which is proportional to the load current and inversely proportional to the supply frequency and the number of output peaks of the rectifier per input cycle.

To further reduce this ripple, a capacitor-input filter can be used. This aids the reservoir capacitor with a choke or inductor, and a second filter capacitor so that the DC output would be steadier. The choke acts as high impedance to the ripple.

This capacitor-input filter is also called a "Pi" filter. This is due to its shape that looks like the Greek letter pi (π). This type of circuit is used to remove unwanted or undesired frequencies from a signal, in our case the ripple from the DC.

The first capacitor, C1, offers low reactance to the AC component while it offers an infinite reactance to the DC component. The inductor, L, offers high reactance to the AC component but it offers almost zero reactance to the DC component. As a result, the DC component flows through the inductor while the AC component is blocked.

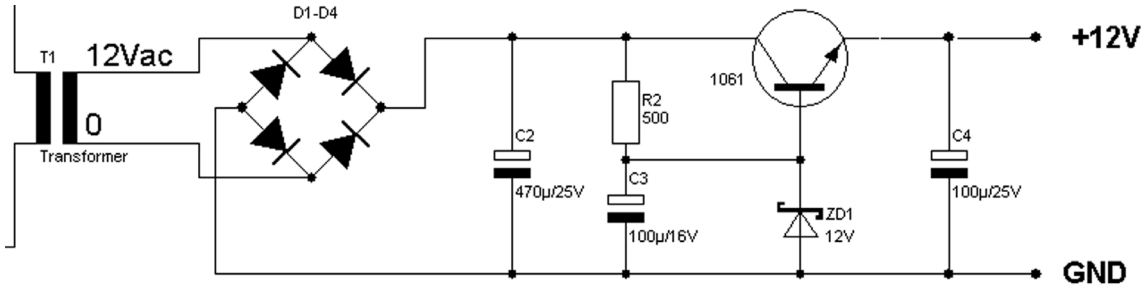
The Pi Filter



The second capacitor, C2, will then by-passes the AC component which the inductor fails to block. As a result, only the DC component appears across the load RL.

Instead of a filter, especially if the DC load is very demanding of a smooth supply voltage, following the reservoir capacitor a voltage regulator is used.

Also, without regulation, the power supply will vary the output it's pumping out according to the variations on the load and the input voltage to the transformer. An unregulated supply generally gives somewhat higher output voltage when it is not loaded at all, generally around 1.4 times



nominal voltage. The output voltage starts to drop as the load increases, giving the nominal output voltage at the nominal load current. The output voltage starts to drop as the load increases, and gives the nominal output voltage at the nominal load current. If the load increases to a higher level from this, the output voltage will drop below the nominal until maximum output current is reached. At that stage, expect things to get pretty hot or the fuse to blow, provided one with the proper rating has been used.

Regulators make the output more secure and reliable for use with most electronic equipment. They also are used to stabilize and adjust the output voltage, as well as greatly reduce the ripple and noise present.

Voltage regulators can be either linear, or they can be switching.

The definition of a voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It may use an electromechanical mechanism, or passive or active electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. Here we will be discussing the type of regulation done by passive or active electronic components.

All modern electronic voltage regulators operate by comparing the actual output voltage to some internal fixed reference voltage. Any difference is amplified and used to control the regulation element in such a way as to reduce the voltage error.

Most regulators also incorporate current limiting protection. Simple regulation can be achieved by the use of a zener diode and a power transistor. More modern linear power supply units use an integrated circuit to take care of the regulation process. The output after the regulation stage would result in a clean and steady DC voltage.

The output voltage is controlled by a power transistor operating in its linear region. It acts as a variable resistor in series with the load. The zener controls the transistor bias to maintain a constant voltage output, regardless of changes in the load current.

In a nutshell, what regulators do basically is produce a fixed DC output from a source having some ripple on it, as explained above.

- James Borg
jborg@slot-techs.com

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About Randy Fromm: I am the publisher of Slot Tech Magazine. First published in 2001, Slot Tech Magazine is a monthly trade journal focusing on casino slot machine repair. I have been repairing electronics for the gaming industry since 1972. I really enjoy what I do and I love showing others how easy it can be. ***No previous knowledge of electronics is required.***

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Randy Fromm's Slot Tech Magazine is published monthly by:
Slot Tech Magazine
1944 Falmouth Dr.
El Cajon, CA 92020-2827
tel.619.593.6131
fax.619.593.6132
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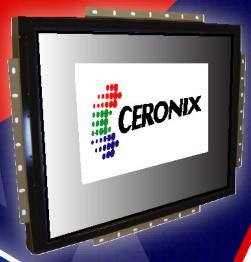

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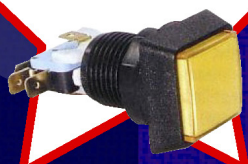

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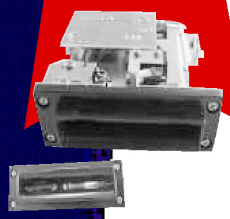
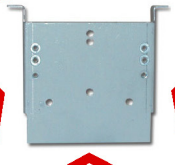


Seating



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