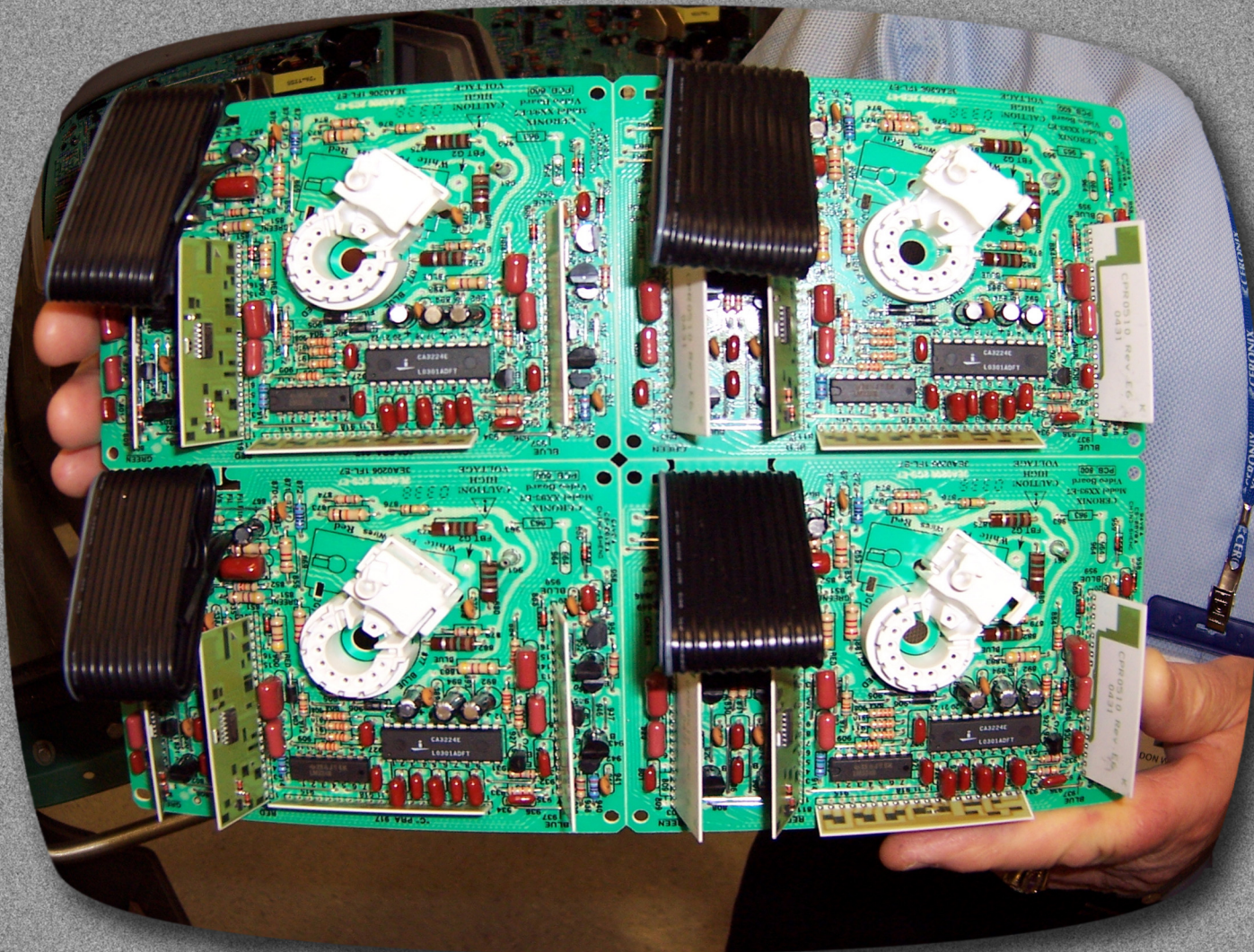# Slot Tech Magazine

Slot Tech

Magazine

Slot Machine Technology for the International Gaming Industry

Slot Tech Magazine Visits Ceronix

Pseudoarchaeology:
Service Procedures That Require Some Digging
Casino Roulette Steals the Show for Kimble
Zendex Casino Video Gaming Board
Don't Throw Your Ballast Overboard
First LCD Repair Class - Sold-Out!
Quick Simple Repairs #11
Flipped-Out Probability

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March 2006

How many $$ does it take to change a light bulb?

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Cold cathode burns cool, using almost 50% less energy than fluorescent tubes. More current is converted to light and NOT heat, so CCFL won't strain air conditioning loads and it won't heat-damage other internal electronics.

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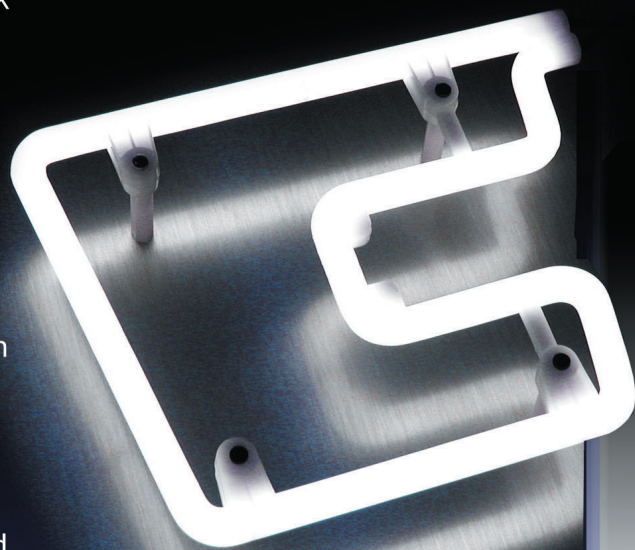
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March 2006

Slot Tech Editorial
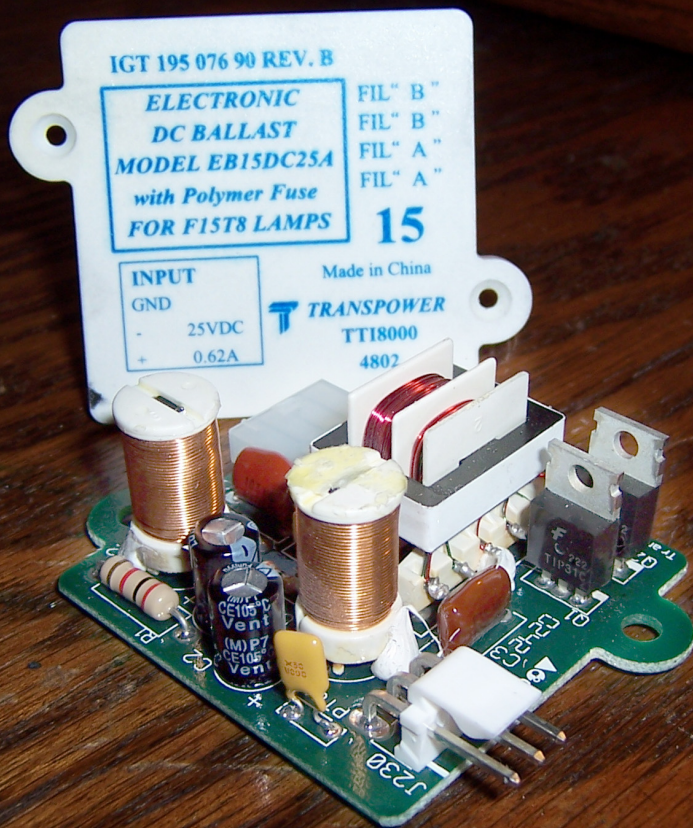
From the Slot Tech Mailbag:

To: Pat Porath
Re: Jumbled CDS Displays

I've seen the CDS displays get jumbled for two reasons, both of which have perhaps easier fixes than mentioned in the article. First, if you are using the 2X16 LCD display and pull the cable out just right, the display will appear to be in Japanese.

For this case, just pull the cable out and re-insert it correctly in the display. If the display is showing some serious gibberish, the display type was probably changed from LCD to one of two VFD types, and the VFD output looks a bit distorted running on the LCD.

If the power is reset while this is happening, the display will show the top eight characters as dim squares. If you can change the display back "blind" this is a bit easier than messing with the EPROMs. Just walk through the display type setup from memory (if you were the one who changed the display type, remember that the first time you put your card in after a reboot will typically reject your card). There are only three display types, so when you get to that menu, scroll through the gibberish until the right type is selected, recognizable by the legible display of "2X16 LCD."

Jason Czito
Black Oak Casino

Thanks for the info, Jason. It's always nice to get reports from the field.

Note: The Slot Technical Department is back up with faster download speeds. Follow the link at the slot-

Randy Fromm

techs.com homepage or go there directly at slot-tech.com (notice, no "s"). Slot-Tech.com is my new technical server where over eight gigabytes of service information (monitor schematics, power supply schematics, service manuals, drivers, software, etc.) is available in one place, free of charge.

I have also instituted a new, "members only" section that carries the entire archive of Slot Tech Magazine (2001-present) in high-resolution, pdf format as well as podcasts on monitor repair, coin comparator repair, BV repair (JCM and MEI), printer repair and others. At the moment, there is over 12GB of additional material in the members only section, with additional content being added continuously. There is an enrollment link at slot-tech.com.

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

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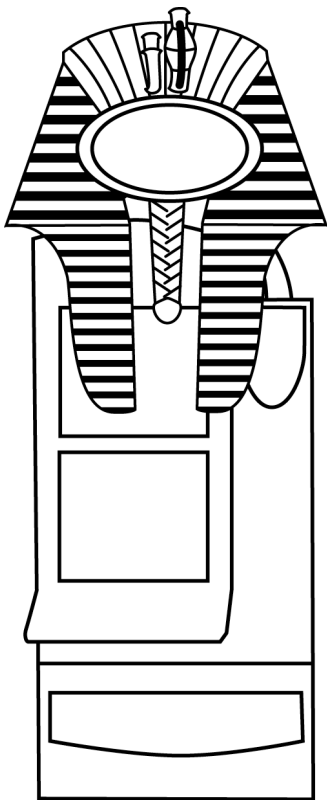### The New Generation for Touch Gaming

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Pseudoarchaeology: Service
Procedures That Require Some Digging

By Michael Brennan

T he scene is three hundred years from now, and a throng of cloned archaeologists is digging through the antiquated ruins of an ancient casino. Hidden beneath the skeletal remains of a Beatles tribute band is a bank of slot machines, including an Atronic e-motion™cabinet.

To uncover the power and connectivity contained within, these scienticians of the future carefully remove, examine, and replace many e-motion™hardware items. A feature of the e-motion™cabinet is that its inner components are spread out as much as possible, making excavation (or service and maintenance) a snap. Because the cabinet's design avoids excessive component layering, a task like swapping out a hopper board is easily accomplished by removing some connectors and screws.

However, our future archaeologists want to access a couple items in the cabinet that do not have self-explanatory removal procedures. While they are busy scratching their heads with their genetically-engineered head-scratching appendages, one eagle-eyed colleague (literally, he has the eyes of eagles grafted into his skull) spots the March 2006 issue of Slot Tech Magazine poking out from some rubble. He reads this article and learns how to remove a playfield, replace a power filter board, take out a backplane, and locate the drop door optic.

What follows is an exercise in slot machine maintenance and pseudoarchaeology (a fictionalized, *Raiders of the Lost Ark* type representation of the anthropological science). We'll examine interesting artifacts of the past, while becoming an informative artifact for any future e-motion™excavation. As for the present, get your shovels, because four e-motion™service procedures are about to be unearthed.

Removing the Playfield of Tutankhamen

While "real" archaeology has led to the discovery of such impressive finds as the Tomb of Tutankhamen (that's King Tut to us), our pseudoarchaeologists' first discovery in the e-motion™cabinet is the "playfield." This fascinating artifact can move up and down, adjusting to the height and preference of the player, whether slumped Java Man or upright Cro-Magnon.
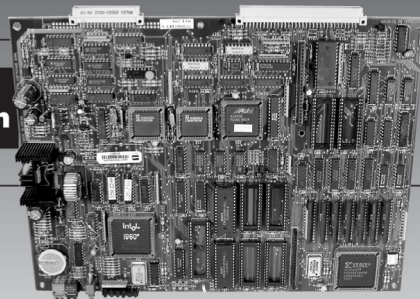
A main reason the tomb of Tutankhamen was surprisingly undisturbed (as compared to other Egyptian tombs in the area) is that many would-be looters completely forgot about King Tut, since he died so young. Similarly, many forget that the e-motion™playfield is movable and convenient. Consider this a reminder,
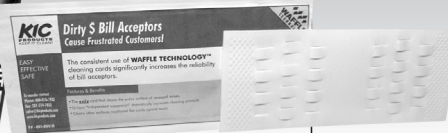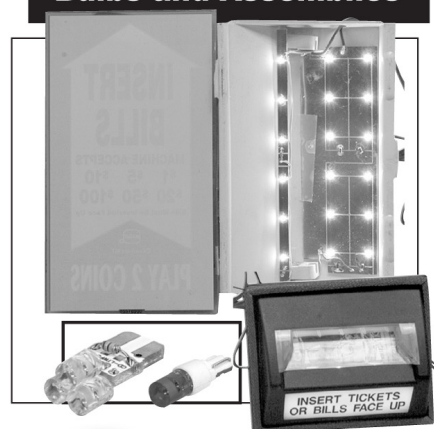
without all the pyramids and mummification.

Back to present times: The playfield is a robust item, meant to withstand much customer poking, prodding and pounding. However, there may be situations when you need to replace an item in the playfield (a TFT monitor or the frame light control board, for example). In these cases, we recommend using a rotating replacement playfield during the process.

This means you should use a "spare" playfield whenever you need to remove a playfield from a game on the floor, rather than leaving the game "faceless." This way, you can fix the in-need-of-repair playfield in the back of the house, while the game remains up and running with the help of the spare.

To remove an e-motion™playfield, begin by disconnecting the cables that exit a hole in the center of the playfield. These cables are routed to the functional button panel (located above the coin acceptor), the graphics card, and the filter board. After cutting a few wire ties to free these cables, unscrew the thumb nut at the top of the playfield arm. Be sure to support the weight of the playfield while you unscrew this nut, because the playfield will drop a couple inches when it is free from the arm.
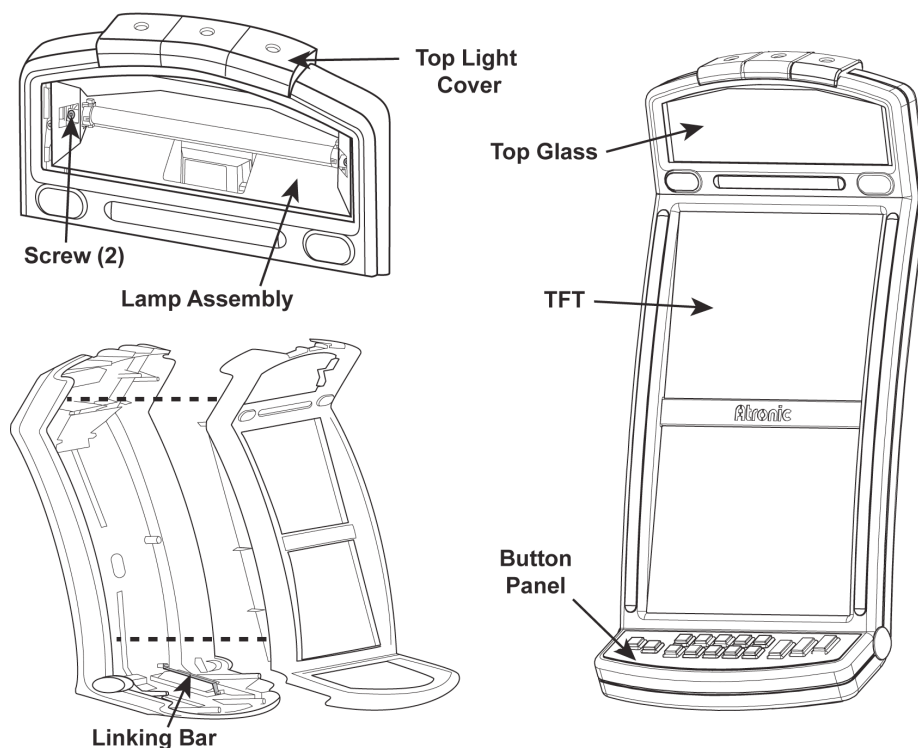
Next to the top glass removal knob (see the illustration) is a metal bracket. When you take off this bracket you can remove the entire playfield assembly from the cabinet by sliding it up on its tracks and then out. Free from its confines, you can take the playfield to a workbench and fix or replace what you like. To remove a TFT, more steps follow.

First, remove the top glass. Locate the top glass removal knob on the back of the playfield. Push in the knob and slide it down to release the glass. To take off the lamp assembly that lies behind the top glass, remove the torx screws at each side of the plate and unhook any connectors. When the lamp assembly is detached, be sure to unscrew two more

torx screws that are hiding just behind. While you're still working in this area, there are two more tasks: unplug the speaker cables behind the lamp and remove the top light cover on the peak of the playfield.

At the other end of the playfield, remove the button panel. The button panel releases in a manner similar to the top glass. Locate the lower removal knob at the back of the playfield. Push it in and slide it up to remove the button panel. Below the button panel there are the two screws. Remove these and locate the center linking bar. There is a nut in the center of this linking bar. Remove it and the bar will separate.

e-motion Playfield

Top Light Cover
Screw (2)
Lamp Assembly
Linking Bar
Top Glass
TFT
Button Panel
Altronic

Next, take out the two Phillips screws at the back of the playfield. When these are removed, you can separate and pull apart the playfield. While you pull the front part of the playfield, carefully maneuver a bundle of cables through the opening in the frame. There are two sets of cables: one will accompany the front face of the playfield, while the other set will remain with the back playfield portion.

Once separated, lay the front part of the playfield face down. You will see the TFTs secured to the frame by six tabs and two locking bars. Remove each of the six torx screws that secure the TFT tabs to the playfield frame. Then loosen the Phillips screws on the locking bars. Loosen them enough to rotate the bars so the TFT can slide out.

Lindow Man Removes a Power Filter Board

As any pseudoarchaeologist will tell you (possibly in a pseudo-condescending tone), some of the best-preserved human remains are found in peat bogs, where the combination of temperature, acidity and other conditions can keep ancient bodies in surprisingly good condition. One such discovery is known as Lindow Man, a gentleman who died around the time B.C. became A.D. He is of note because of the extreme way he was laid to rest. It's believed Lindow man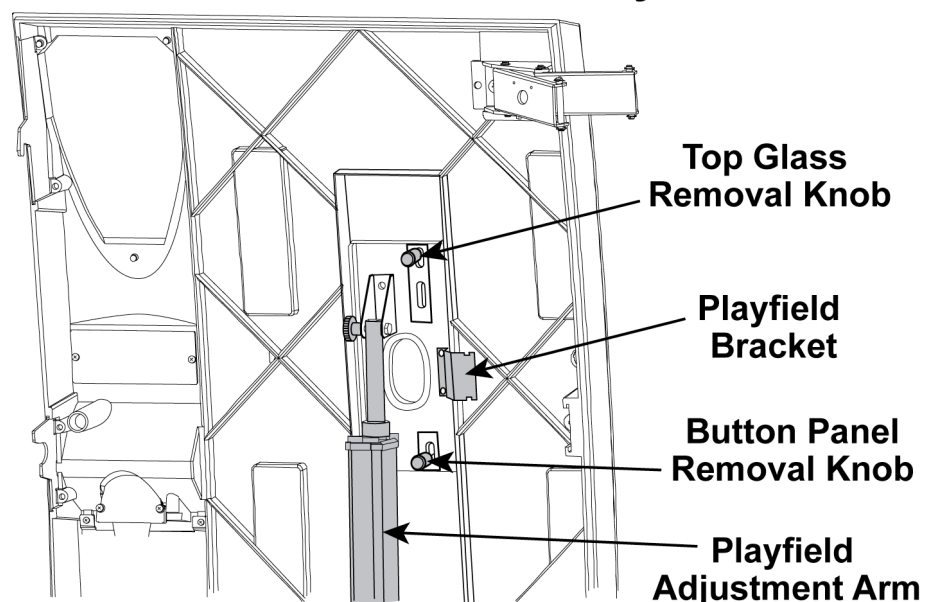 was killed by three hits to the head, a cut to the throat, and a twisted noose around his neck (triplism). For some, this suggests that he was probably sacrificed or possibly executed.

Lindow Man appears to be of elite status, and whether he was a human sacrifice is up for debate. If he was sacrificied then he is not unlike... the power filter board, an e-motion™component that will fry itself in the rare event that there is a power surge from the power supply in the cabinet. To replace this board, follow the ensuing procedure. And if you are the eagle-eyed man of the future, try to keep your head from exploding when contemplating the layering and Alanis Morissettesque irony of finding and using an artifact (this article) that uses an even older artifact (Lindow Man) to explain how to use another artifact (slot machine). It would be equally mind-blowing to simply contemplate that someone presaged your existence... but back to the power filter board.

Since the power filter board is located on the far left of the logic box (close to the cabinet wall), you must take out the entire logic box to remove this board. Start by disconnecting the three cables that run from the power supply to the power filter board. Next, remove all the cables that are connected to the signal filter board, which is located at the front left of the logic box. These cables are bundled together and clipped to the top of the logic box. Since you will be removing the logic box, you must unclip these cables. Instead of letting the cables hang in the way, secure the bundle in a extra clip that is mounted to the top of the cabinet for convenience.
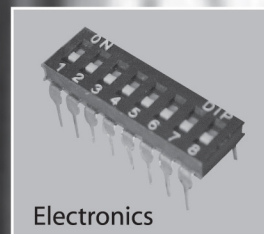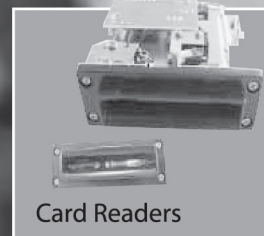
Back of e-motion Playfield

Top Glass Removal Knob

Playfield Bracket

Button Panel Removal Knob

Playfield Adjustment Arm

Next, remove the cables that are attached to the bottom of the logic box. Remove the two cables running from the TFTs to the graphics card and the two serial cables running to the multimedia board (they come from the frame light control board and the touch screen controller). Open the logic box main door and disconnect any cables attached to the commboard, like player tracking or progressive cables. The logic box should be completely free and you can now take it out of the cabinet.

Three 7mm nuts on three threaded posts connect the logic box to the cabinet. Remove the two nuts in each upper corner and the single nut in the bottom center. Pull the logic box out and locate the power filter board on the left side. All that remains are sheet metal screws that affix the power filter board to the logic box. You'll have time to contemplate the mysterious death of the Lindow Man as you remove all fourteen screws.

The Backplane: Rosetta Stone of the Logic Box

The Rosetta Stone is an archaeological artifact with enough cultural significance to make it a commonly-accepted metaphor. Discovered in 1799, the stone details an Egyptian decree, but its value lies in its ability to translate hieroglyphics. In a metaphorical sense, a Rosetta stone is something that is the main key or link to understanding something else. In a way, the e-motion™backplane is the logic box's Rosetta stone; it links all the circuit boards in the logic box and functions as a distribution center. Without a backplane, e-motion™game components cannot talk to each other. And that's an arti-fact.

To remove the backplane, start by pulling out the main board and commboard. You'll also need to remove the graphics card by disconnecting the TFT cables and its retaining screw. The next step is to remove the multimedia board. Disconnect the cables coming from the touch screen controller and the frame light control board. After you remove its power harness, remove all the screws that hold the multimedia board in place.

After the multimedia board is out of the way, remove the signal filter board. You can leave all the front connectors in tact, but you must take off every connector cabled to its back. Once disconnected from the backplane, you can place the signal filter board above the logic box, out of the way.

Finally, remove the cables that run from the power filter board and remove the multiple sheet metal screws that affix the backplane to the logic box. Now, pull the backplane down and out of the logic box.

Accessing Otzi's Drop Optic

Found in a glacier in the Alps, Otzi the Iceman is one of the oldest known human mummies, from roughly 3300 B.C. Some might joke that slot machines that accept coins are just as old, but not us.

Atronic e-motion™cabinets configured for coins contain six optics. Five of these are easily located near the coin comparator. The other optic, the drop optic, is hidden near the bill validator assembly. To access the drop optic, open the cash box door. Directly behind the little ridge at the front bottom of the bill validator assembly is a single machine screw. Remove this screw and pull out the bill validator assembly.

The drop optic is located in the area that the bill validator assembly just vacated, mounted to a bracket on the left-side wall near the bottom of the cabinet. Unscrew the silver thumb nut to remove the drop optic.

While examining the past, we have dug up some involved e-motion™procedures. And our diggers from the future received the information they sought. Dutifully impressed, they have taken the e-motion™cabinet and placed it in the Great Artifacts of the World exhibit in the Hillary Clinton World Museum. Under a soft spotlight the cabinet sits, right next to King Tut, Lindow Man, the Rosetta Stone and Otzi.

- Michael Brennan
MBrennan@atronic.com

Are LCD display problems driving up your costs?
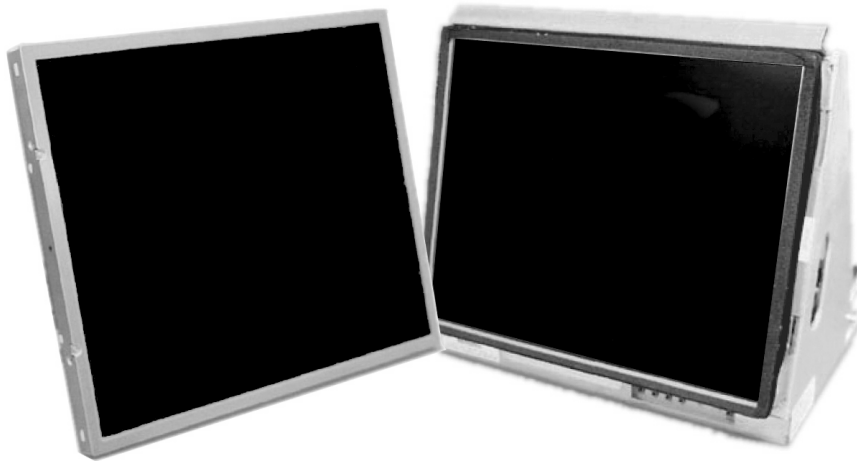
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HVT

Quick Simple Repairs #11

By Pat Porath

I.G.T. S2000
   A coin out error

when the game is coinless and has no hopper? I've run into this one a few times. First of all, how is it possible to have a coin out error when the game is suppose to be set at coinless with no hopper? Not really sure on that one but I come across it once in a while. A game will have credits on it and the machine thinks it is supposed to pay out of the hopper but there is no hopper. One thing to do is find a similar game nearby that has a hopper and cash out the coins. Of course, you can't do this if you're 100% coinless.

The way I do it now is kind of simple and it works. The power is shut off and the main board is pulled. Remove the RAM chips. Then put the chips back in the game and power up. This will give a RAM error and in the end, erase the credits and enable you to properly set the hopper option. Clear the error by a combination of the jackpot reset key and the test button to get the game back in idle mode. The credits will be gone. Then go into your hopper options and set the HOPPER LIMIT to zero. This will make the game pay in tickets and not the hopper. Like I stated earlier, I'm not sure if someone else was in the game and accidentally set a game option incorrectly or a maybe a minor RAM corruption or what the deal is. You also want to check the rest of your game options just to make sure nothing else is set incorrectly. In a nutshell, you force a RAM error to erase the credits, perform a partial RAM clear, properly set options, check the rest of the game options, then the game is back in action.

From Q&SR #9: Aristocrat with a 750 Ithaca Printer, Showing "Printer Disconnected"

I had an Aristocrat game with an error of "printer disconnected." I opened up the game and checked the connections. They all seemed ok. The printer had power because the LED was on. I did notice that the paper was in upside down. That may be why the customer received a blank ticket. I also THOUGHT (sometimes a mistake) that if the paper was reinserted properly that the error would clear. No such luck. I fed the paper in a few times, pressed the paper feed button a few times and the paper would feed ok, but the error still wouldn't clear. I rebooted the game twice, opened and closed the main door and still no luck. Armed with a replacement printer, I replaced it and printed some test tickets. The game was fine. Be careful not to hold the service button too long while testing, otherwise it will continue to print three or more test tickets in a row.
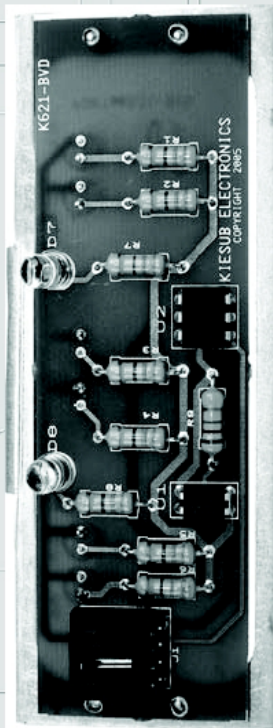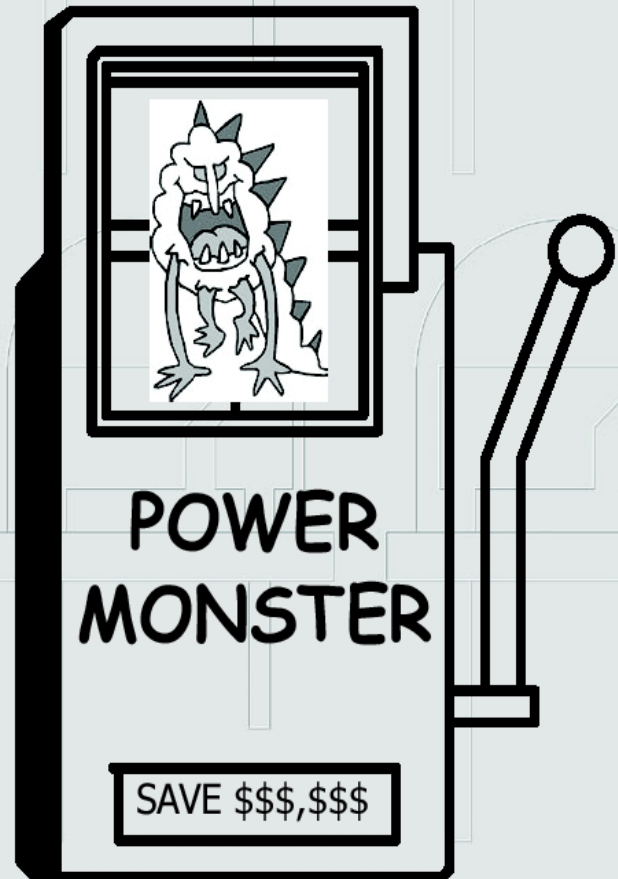
Editor's note: Hey, Pat. Did you ever find out what was actually wrong with the printer you replaced?

The response: To the Editor -- The Printer and the Bally

If I recall correctly, the main problem with the printer was a software conflict. With the various types of printers and various types of software that are in the printers, there can be problems. Off the top of my head I can think of an Ithaca 750, that one type is for WMS games and the other is for Aristocrat. Seiko (called FutureLogic now) has two different types: The Netplex type for IGT games and the RS232 type for the Bally games. The Ithaca 850 has software specific for WMS games and the newer type Aristocrat. On the Seiko there is a small sticker on it that identifies the two. On the Ithaca 850, it seems that most but not all are marked what version of software there is in them. However, with the removal of four screws, the PLCC chip is right there to see what it is. For example, it may be Revision 31 or Revision 37.

Anyway, with that specific Bally game, it knew that a printer was there but the game couldn't communicate with it. The main processor may have said something on the order of "Hey, I see you there printer but I don't understand what you are saying." With the PROPER PRINTER AND PROPER SOFTWARE IN THE PRINTER, the main processor would say something like

"Hi printer, there you are. We have good communication, you have paper, your paper isn't low and we are ready." It is more complicated than that but you get the idea. More than likely the printer was tested on the bench in the shop at the "NETPLEX" setting and tested fine. It would be put on the "good" shelf and be "RFI" (ready for installation).

IGT S+ Coin-In Tilts

On an IGT S+ game, if there are a lot of occurrences of "code 21s" or a lot of general coin-in tilts, there is a fix that may solve the problem. "Upgrading" the coin in assembly may do the trick. When the assembly is taken apart, you will notice there are two separate pieces of black plastic. In each, there are three holes. The trick is to grab a drill bit and drill out the six holes just one size bigger. Simply drill the holes a tad bit bigger and the coin in errors will almost disappear.

What this actually does is make the "optic path" a little bit larger. On the coin in optic itself, there are three infrared emitters and three infrared receivers. If the path in which they shine is larger, the game will more than likely tilt less, especially if they are out of alignment a bit. More or less, the three emitters shine through the plastic and the receivers pick them up. Think of it like a flashlight shining through a one-inch piece of pipe, and then shining through a two-inch pipe. You kind of get the idea. After the plastic is drilled out, simply reassemble and install it back into the game.

Another item that is a really good idea to do is clean the optics. When the assembly is taken apart and a big dust ball is blocking one of the optics, that very well could be the problem. I clean the optics with a dry cotton swap. Using alcohol may eventually "fog up" the optic. If the prob-

lem still persists after cleaning and "upgrading" the assembly, it may be a problem with one of the optics themselves. Simply replace them with a spare if you think they may be bad.

WMS Kristel LCD Repair

First of all, yes FIRST of all, make sure to check the warranty on the LCD. The unit has "security seals" on it in addition to the security screws that are on it. In short, if the LCD is under warranty and the seals are broken, the full price has to be paid for a replacement. Maybe around $900...give or take. Well with that covered, the unit has a pile of security screws that have to be taken out. We had to buy a set of special bits to remove the "security" Allen screws. But, if you consider that one can be repaired in a short time, it is WELL worth it.

What is the problem with the LCD? Well, it is black. Could it be a power problem, wires, connections, the graphics signal being sent to the LCD, the main processor or what? Come to find out it seems to be a main power problem with the unit itself. In fact, it is a FUSE problem. You may think, what is the big deal? Replace the fuse and get it running again. Well, it is a little tricky. These are small "surface mount" fuses. The only way to really tell if it is bad is to take a multimeter to it and check for continuity. By looking at the fuse, which is marked "F 1", you can tell that it may be bad because it will look a little bit dark. Come to find

Backlight Inverter

Kristel Corporation

NBL01C.SCH

out the unit has TWO fuses that may go bad. One on the power input side and the fuse on the VGA (video input) side that may go bad also. I'm not sure exactly what causes it though. It is obvious on the outer part of the unit which side is which. The VGA side is where the standard 15 pin sub-D connector plugs into. The other side has a DVI connector.

Now...think of this. It is a Friday afternoon and on a very popular penny WMS game, the main LCD goes out and you DON'T have a spare on hand. The game may be down all weekend. Not good. What we do is take out the pile of security screws, look for the bad fuse and carefully solder in a piece of trace wire to jump the fuse. Reassemble it and install it back in the game. If your solder work isn't the best, you will want someone with experience to put in the jumper. It is very tight quarters to do this procedure.

LCD Repair in Detail

Once the covers are off of the power board and the video board, it is pretty easy to see where the two fuses are located. There is one fuse on each board, somewhat of a tan color. They are marked right on the board "F1." This symbol is standard on circuit boards. F1, F2, and F3 all are fuses. It is the same with capacitors. C1, C2, and C3 all being caps.

Back to the LCD, the fuses are surface mount, which are very small. If you have the surface mount solder equipment with hot air and such, then of course, solder in an exact replacement. We don't have one yet at the casino I work for, so we use the "jumper wire trick" with the trace wire. In the case of a bad LCD, check the warranty, disassemble, perform the "jumper wire trick" (or, preferably, replace the fuse if you have the equipment) reassemble and the game is back up and running. This also works with the IGT smaller LCDs. I never done it on that specific type but it has been done at the casino I work for. It is the same thing. Check the warranty on it (the IGT ones may be around $2000 or so) disassemble, "repair" or replace the bad fuse, reassemble, and the game is back online. These are the small LCDs that are in IGT Vision games such as the "Diamond Mine" or the "Balloon Bars."

- Pat Porath
pporath@slot-techs.com
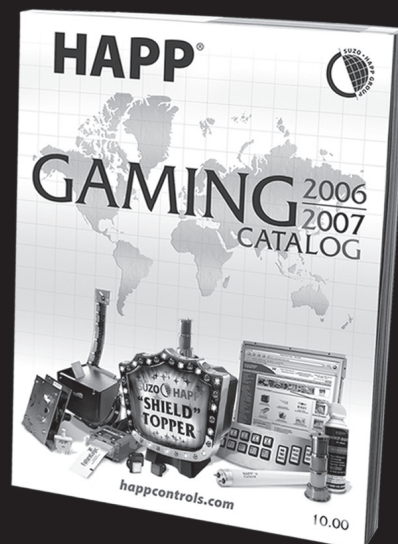
LCD Repair Class Sold-Out In San Diego!

This was Slot Tech Magazine's premier LCD repair class. The three-day event was held February 7-9, 2006 in the spacious new slot tech training facilities at Sycuan Casino, near Slot Tech Magazine's home base in El Cajon, California. The class was instructed by Ray Holdren (great job, Ray) working in conjunction with Sencore, who provided all the gear (the trainers and the test equipment) for the event. The next class is planned for April 24-26, 2006. See the website at slot-techs.com for details.

" I just wanted to say a very big thank you for the LCD course held at the Sycuan Casino. The trip from New Zealand was well worth it and we would do it again without a moment's hesitation. We have started to apply what we learnt from the course with just success. I can see us reducing our yearly repair costs by an easy 90%. "

Regards,
Mark Kelynack
National IT / Projects Manager
Advance Gaming (NZ) Ltd

Ellery Navo, Boe Woonsook, Fred Faulhaber and Ron Hendricks Jr.made up Team Shoshone. They came from the Fort Hall Casino in Blackfoot Idaho.

Phoenix-based electronics mavin Larry Rosenthal (l) teamed up with Mark Kelynack and Brayden Whale from Advance Gaming/Konami (New Zealand). They hold the record for the furthest distance anyone has ever traveled to a Slot Tech Magazine training event (the previous record was held by Rick Gardaya who came from Japan to attended TechFest 2 in Las Vegas).

LCD Repair Class @ Sycuan Casino
February 7-9 2006
San Diego, California

Ray Holdren
Instructor

The Mill Casino's Joe Jeffries (l) with my homeboys Anthony "Tony Fresh" Houghton (see tonyfresh.com) and Jesus Garcia from Sycuan Casino.

Graduates from Slot Tech Magazine's premier LCD repair class: Michael Ryckman, Harrah's Laughlin, Juan Morales, Paul Ulloa-huerta, Barona Valley Ranch Casino, Larry Rosenthal, Rosentahl Enterprises, Ellery Navo, Boe Woonsook, Fred Faulhaber, Ron Hendricks Jr., Fort Hall Casino, Mark Kelynack, Brayden Whale, Advance Gaming (NZ) Ltd. / Konami, Anthony Houghton, Jesus Garcia, Sycuan Casino, Jake Cook, Casino Pauma

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Flipped-Out Probability

By John Wilson

On a sunny, yet rather cold, Wednesday morning (I'm in Canada, eh?) you walk into the Slot Tech Casino & Hotel. Your new job as "Junior Director of Slot Machine Operations regarding Math, General Stuff and Miscellaneous Things" couldn't be better. Although Uncle Charlie (curiously enough, the owner of the casino) arranged for you to get the job, he could have come up with a name that didn't suggest the fact. But, I digress . . .

Walking into your boss' office for your regular morning review, you see her staring at a slot token.

"A sample of a new token, Mandy?" you ask. "I thought we were planning on using TITO."

"Yes, we are. And, no, it's not a sample. I'm just curious about this math stuff we've been reading about in Slot Tech Magazine. I'm wondering about this slot token."

"What do you mean?"

"Well, suppose that I flip this in the air and catch it. There's a 50% chance of it landing heads, and a 50% chance of it landing tails."

"There should be." you reply.

"Then what's the probability of getting heads twice in a row? How often will it land heads five times in a row?"

"We can figure that out by using the probability of one slot token toss and then looking at five of them. I'm not sure how to do this, but I know that it can be calculated."

"Yes, I can almost understand it, but compare this token to our new Max Millions games. The top jackpot is a million dollars on a quarter machine. It shouldn't happen very often."

"Right, Mandy. If we look at the PAR sheet, we can see the probability, or look at the number of games that will occur between wins. If there are 16 million games between jackpots, we know that it will take 16 million games to hit the jackpot."

"In theory. A player could hit the jackpot on the first spin."

"Yes, but it will be a long time between wins, even in that case."

"True. But remember the article on the pull-tab theory of slot machines? We know that the outcomes in a cycle aren't absolute. If there is only one jackpot in a cycle, the machine won't avoid awarding another jackpot until the correct number of games has been completed. Even with one jackpot in a cycle, we could have two jackpots occur before one cycle has been completed."

"Yes," you agree. You think about this and wonder where she's going. You know there's going to be a "but" or a big question that you have to answer. Sweat begins to form

on your forehead. In the distance, a coyote howls.

"Then we could have two jackpots come up one after another, even though the probability of this is, well, not very probable. How do we calculate that?"

"I'm sure there's a way. It's probably not very difficult, but . . ."

Mandy interrupts you before you have a chance to bluff your way through an answer.

"I just do not understand this very well. Let's take our slot token and flip it in the air ten times. I want to know the probability of it landing on heads every time. If we get nine heads in a row, what's the probability of getting it once again? How do we calculate that?"

"That's a good question!" you respond. You stare off in the distance while rubbing your chin, appearing to be deep in thought. "Yes," you think. "This woman needs a life. If I nod my head as well, I'll look very studious. Perhaps her phone will ring soon and I'll have to leave."

"What about your friend that worked on the Max Millions game? Lenny?" she asks.

"Larry. Yeah, I'll go give him a call."

As you get up to run from her office, she turns the phone toward you. "Put it on speaker and we'll see what he says."

Settling back into your chair, you dial Larry's number. He answers on the third ring. (Did I mention the coyote howling in the distance?)

"Larry, I'm in my office with my boss on the speaker phone. She's wondering about probabilities. Do you have a couple minutes?"

"Always. What's your question?" replies Larry.

"Suppose we take a slot token and toss it in the air. There's a 50/50 chance of it landing on heads or tails."

"Right," he agrees.

"What about ten times in a row? What is the probability of it coming up heads each time? What about after nine times? What's the probability of the next toss being heads?"

Mandy interjects. "Hi, Larry. I guess I'm thinking about a large slot jackpot, too, like your Max Millions. You could have the jackpots hit back to back, but how do we determine if this can happen and how frequently?"

"I think what you're experiencing is a probability fallacy. It's like a roulette game coming up red twenty games in a row. Do you bet on black because it hasn't happened in a long time, or do you bet on red because you're in a red streak?"

"I'd bet on green, Larry." you muse.

Larry offers his explanation.

"There's a common belief that probabilities aren't purely mathematical or that odds have some form of memory. Once an unlikely event has

Heads or Tails?

happened, it's difficult to believe that the probability of it occurring again hasn't changed. Take your coin toss. If you have nine heads in a row, you have the same odds of the coin toss coming up heads the next time as you did the first time. There's still a 50/50 chance."

"But," Mandy asks, "the odds of nine heads coming up is very low. The odds of ten is far less. It can't be 50/50, it must be much less. I know that it shouldn't, but it must."

"That's what is hard to understand about this, Mandy. Let's take a look at your slot token from a purely mathematical point of view. If we take a simple object like your slot token, we can then expand onto your slot machine. Say, aren't you going to be implementing Ticket In, Ticket Out here?"

"If we have a slot token, there are two sides: heads and tails if you wish. Numismatists call it the obverse and reverse sides. Let's just use heads and tails. If you flip a coin, it can land on either side. Assuming that the material is consistent within the coin and that it is properly bal-

anced, each side has an equal opportunity of landing face up. There are two sides with equal chances of landing, so the odds are one in two. You have one chance out of two that the coin will be heads. You could also state that there is an equal chance by saying it's 1:1. Probability just seems nicer to work with. If you have 1 out of 2, then you will have heads ½ of the time and tails ½ of the time. We just divide this fraction and say that the probability is 0.5."

"Now, let's look at two coin tosses. Each one has the probability of heads as 0.5. You want to know what the probability is of two heads coming up one after another. That's slightly different. Picture a grid with four squares. On the top put HEADS and TAILS. Down the left-hand side, put HEADS and TAILS. Where the rows and columns meet, write down the word from the top and from the left. Fill in each square."

"Ok, Larry. Let me do this on the white board." answers Mandy. "Alright, I see we'll get

heads once, tails once, and heads and tails twice."

"Correct. If we count the squares we see four possible outcomes in our two tosses. One of them will be two heads. That means that we have a 1 in 4 chance, or the probability is 1/4 or 0.25."

"That's going to be pretty hard to draw for ten flips, though," states Mandy.

"Then let's do it mathematically. If the probability of heads landing once is 0.5 then the probability of heads landing twice is 0.5 multiplied by 0.5, or 0.25. You could also think of it as a fraction. ½ multiplied by ½ is 1/4, or 0.25. Knowing this little formula we can calculate the probability of heads happening ten times in a row. We simply take the probability of heads and multiply that number by itself nine times. We have 0.5 x 0.5 x 0.5 x 0.5 x 0.5 x 0.5 x 0.5 x 0.5 x 0.5 which is 0.001953125. We could also show it as a percentage by multiplying by 100. It will happen 0.195% of the time, or much less than

To get from coin flip #9 to coin flip #10, there's still a 50/50 chance that you will end up 'heads'.

0.001953125 X (0.5) = 0.0009765625

0.0009765625

0.001953125

0.125

0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5 ✖ 0.5
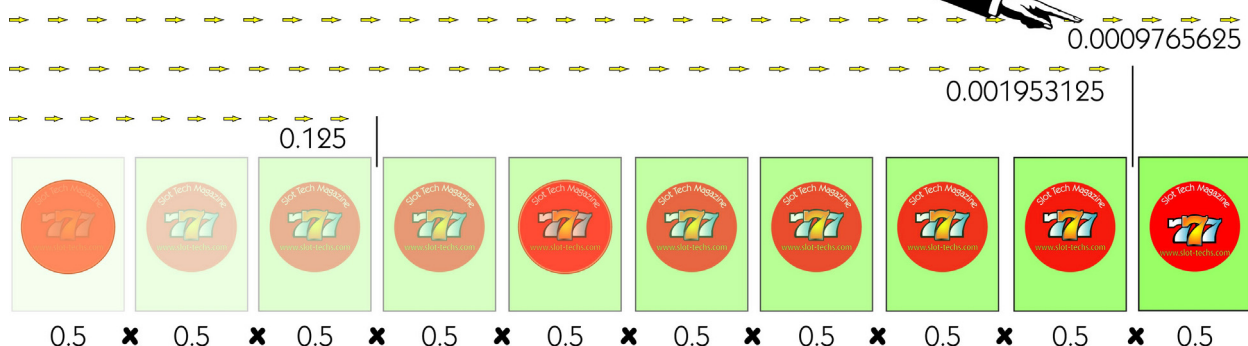
one percent of the time. Now, using this formula, the probability of ten heads is 0.0009765625. That's considerably less, roughly 0.0098%."

"Aha!" Mandy exclaims. "I've got you! If the probability of nine heads is 0.00195 and the probability of ten is 0.00098 then it's not just fifty-fifty. The probability is way less. How do you explain that?"

Mandy looks quite satisfied making that stellar revelation. You sit in your chair confused. Why couldn't your uncle get you a job in the hotel?

"I see what you're thinking, Mandy, "counters Larry. "But you have to look at what has changed between the probability of nine heads and the probability of ten heads. We know that the probability of one toss being heads is 0.5. If we take the probability of nine heads, 0.001953125 and multiply that by 0.5 we get 0.009765625. On paper it looks so much smaller that it doesn't seem it's a fifty-fifty chance on the tenth toss. However, we simply multiply by the single probability and get our answer."

"That might be but it still doesn't explain one thing. If we get nine heads and are hoping for a tenth, we have a probability of 0.009765625. That's so small it won't happen. The odds are against us. It can't happen!"

"You're partly correct, but you're thinking of odds as having emotions and some control over the outcome. Look at it this way. When you had nine heads in a row, you overcame astronomical odds to arrive at that point. It was very unlikely, but you did it. Now you think of the odds of getting ten heads in a row. It's so much smaller that it can't happen. However, you've already overcome tremendous odds. You're almost there. You're only one coin toss away. The fact that you've received nine heads is amazing. Ten is just a fifty-fifty chance. Don't consider the probability of having the coin show heads nine times in a row. That's done. It doesn't matter any more. You have to remove the emotional side of the odds and probabilities and look at the math. Ten heads in a row might be practically impossible, but nine is almost impossible. You have to get to nine before you get to ten. After you're at nine, forget about what has already come. Probabilities deal in future events. Once the even has happened, the probability is irrelevant. People often think of this when they consider the weather. The forecaster says that the probability of precipitation is 50%. You look out your window and it's raining. Isn't the probability of rain 100%? The forecaster was correct; there was a 50% probability of rain. It happened. However, it's now in the present. You can't think about the past. You're already there. Just think about what comes next."

You try to relate this to your slot machines. "Larry, "you ask, "how does this relate to Max Millions? Suppose the top jackpot occurs once in 16 million games. That means there's one chance in 16 million and the probability would be one divided by 16 million." You pull out a calculator and in a moment have the answer. "0.0000000625. Pretty small probability for sure. Suppose that I'm sitting down at the game and I hit the jackpot. My next spin could be a jackpot as well. What's the probability of that happening?"

"The same as before." answers Larry. "It's 0.000000625. Each spin has the same probability and the slot machine doesn't remember the spin before. It won't say 'Oh, yeah, I just paid a jackpot. I better not pay another one or the boss will be upset with me.' While you're asking what the probability of another jackpot is, you're really thinking 'What is the probability of two jackpots occurring one right after another?' For that, multiply the two probabilities together, just like we did for the coins. As you can imagine, it's a very small number."

"Yes, it is. I calculate it to be 0.00000000000000390625. That would be one chance in 256 trillion."

"Exactly!" answers Larry. "Remember, you've already done half the work in getting the first jackpot. The odds really were against you. You now have the same odds of

getting another one. Certainly they're very small odds, but you have the same odds. You likely won't ever see this happen because the probability is very small. If you take an occurrence with a larger probability, like mixed bars, you will see that happen. Suppose that one out of every 10 spins is mixed bars. The probability is 0.1. If it happens twice in a row, the probability is 0.1 times 0.1 or 0.01. That will happen once every hundred spins. If the player is there for 300 games, they'll likely have mixed bars back-to-back three times."

"Why, then, "asks Mandy, "Do we say things like 'likely' or 'on average'?"

"We can't give absolute values," replies Larry, "since we're dealing with a random outcome and one where every outcome is available ev-ery time. In the pull-tab game, every time an outcome happens, it is removed from the game. In that case we can say with absolute certainty that a $25 ticket will be won every 100 times. We know that for certain. While there is a random element involved, it only means that we can't say when it will happen. With a closed set of possibilities however, we can absolutely state that when we deal with a bag of 100 tickets, one of them will be a $25 winner. It could be the first ticket, it might be the 26th ticket, but it will happen."

"I think I understand," you respond. "The random element makes it hard to say when something will happen. The fact that winning combinations aren't removed from the machine means that the same event can happen more frequently than we expect. It just adds a double-layer of uncertainty on our calculations."

"Correct. Remember that probabilities only deal with future events. When we wonder what the probability would be for an event to happen, we sometimes consider past events. Are you asking about the probability of the next coin toss being heads, or are you asking about the probability of ten coin tosses being heads? It's a common fallacy that the machine remembers the previous spins or that the previous spin somehow affects the next spin. Each successive slot game is mutually exclusive from the previous one, meaning that they are entirely unrelated to each other. While the probability of two back-to-back jackpots may be very small, if you already have one jackpot, you're part way there. I hope this answers your question."

"Yes, it does. Thank you, Larry." answers Mandy.

"Thanks for taking the time to speak with us. I wasn't sure if we would catch you in your office." you state.

"It's about a 50/50 chance that I'm in the office." answers Larry.

"Then we caught you in the office this time. Next time it's still 50/50, then." you state.

"Correct! Have a good day."

- **John WIlson**
jwilson@slot-techs.com

Game #1

The probability of this jackpot is 0.0000000625
OR, the jackpot happens once out of 16,000,000 games.

Game #2

The probability of this jackpot is 0.0000000625
OR, the jackpot happens once out of 16,000,000 games.

On-Site Slot Tech Training
Customized Classes Available

Randy Fromm's Casino School is a practical, no-nonsense look at how gaming machines work and how to repair them when they don't. **No previous knowledge of electronics is required** to get the most out of the school. The Casino School is geared for those who want to learn how to fix gaming devices without having to learn complex electronic theory or purchase expensive test equipment.

Be prepared for six hours of accelerated learning each day. Class begins at 9:00 am sharp each day and continues until 4:00 pm. The Casino School provides each student with reference materials and troubleshooting guides that will be valuable aids for repairing equipment on location and in the shop.

Students learn how to work with:

THE DIGITAL MULTIMETER

This relatively inexpensive piece of test equipment is easy to operate. Casino School students learn to use the digital multimeter to perform tests and measurements that will pinpoint the cause of a failure down to a single component.

ELECTRONIC COMPONENTS

The individual components used in games are introduced. Parts such as resistors, capacitors, diodes, potentiometers and transistors are covered individually. Students learn how the components work and how to test them using the meter.

SCHEMATIC DIAGRAMS

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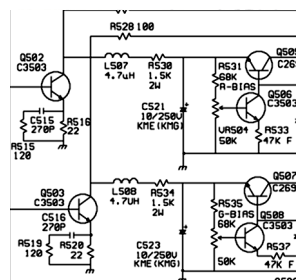
POWER SUPPLIES

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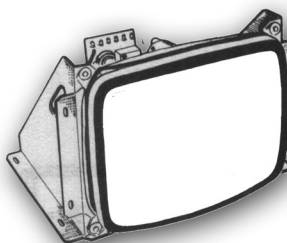
MONITOR REPAIR

The monitors used in video slots are designed for quick, easy, and safe repair. Students will learn the theory of operation of all types of monitors and how to repair monitors down to the component level. Of course, monitor safety will also be discussed.

You do not have to send your slot techs to Las Vegas or Atlantic City for training. The Casino School brings the training to you. Contact Randy Fromm's Casino School today to reserve a date for your tech school

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Slot Tech Magazine Visits
Ceronix

Regular readers of Slot Tech Magazine know that one of my most favorite things to do is to visit factories, especially monitor manufacturers. I have visited quite a few across the country and around the world. During a recent training mission at Thunder Valley Casino (Sacramento, California), I took a quick side trip to visit my friend Don Whitaker at his Ceronix monitor factor in nearby Auburn, California.

I say "my friend" as if I enjoy some sort of special relationship with Don but quite frankly, Don is everyone's friend. It doesn't matter if you are a customer, a competitor or a total stranger, Don will always be genuinely happy to see you and speak with you

CRTs come out of the warehouse (l) with the yokes and convergence rings already mounted and aligned (yammed). They are assembled here by joining them with the metal frame and the electronics chassis. From here, the assembled monitors pass through a large burn-in room (the large, glassed-in area in the background) where they spend the next 24 hours at high operating temperature.

about monitors, about manufacturing processes and about how it can all work together in an environmentally friendly manner. More about that in a moment.

The Ceronix factory is situated on 21 acres between the Auburn airport and the public golf course. The spacious and immaculately clean facility occupies 63,000 square feet. The lobby is a very nice affair but naturally, I breezed right through it on my way to see the actual plant itself. What I saw (mostly) was racks and racks of monitor chassis in various stages of completion.

"We don't stock anything," Said Whitaker, gesturing toward the wheeled racks of PCBs. "We have orders for all of these and they'll be shipped in the next couple of days."

Stocking completed monitors is just not a viable option for a manufacturer that offers over a hundred different products: Monitors of different sizes, monitors with different resolutions, monitors with different frames (form factors) as well as input voltage and impedance differences.

Automation is the key to fast turnaround at Ceronix. The plant is as automated as any I have seen, worldwide. Automated insertion machines are used for almost every component on the board. These high-speed component insertion machines grab the component off a tape reel (for axial leads) "ammo pack" (for radial leads) or from gravity-fed DIP (dual, in-line package, used for integrated circuits) tubes, insert them in the printed circuit board, cut the excess component lead (when necessary) and "clinch" the leads, bending

March 2006

them on the bottom of the PCB so they don't fall off the board during the remainder of the manufacturing process.

The PCBs then pass through an automated wave soldering machine. The output is a perfectly soldered PCB but it still has flux residue from the wave soldering process. Time to take a bath! In the past, this meant dipping the PCBs in a bath of chlorinated hydrocarbon solution. Great for dissolving the flux but oh-so-bad for the environment. Ceronix uses water-soluble flux and a bath of biodegradable Simple Green soap to accomplish the task. And yes, your Ceronix PCB is 100% dishwasher-safe so feel free to wash it if you're operating in a bartop or out on the end of a long, dusty road somewhere.

In another bid to be environmentally conscientious, Ceronix sports the largest commercial photovoltaic array west of the Mississippi. Generating a peak 400 kilowatts, the solar array does more than just lower the plant's electric bill.

"California actually has excess generating capability most of the time," said Whitaker. "It's during the peak hours from noon to 2:00 pm where we run into problems. Our solar array is aligned to provide their peak output during that time period when it's needed the most."

But it's not all altruism for Whitaker in this regard for it is during this peak time that the utility charges the most for its electric power and, therefore, must pay the most for alternative energy that is poured back onto the grid.

"The entire 2.4 million dollar installation is completely

paid off in just 40 months," stated Whitaker.

Like every other manufacturing facility, Ceronix uses wa-

ter, not only in the Simple Green solvent bath but with all of the other requirements that go along with any business. Ceronix pumps water

Ceronix founder and owner Don Whitaker began his career in nuclear physics. Approximately twenty years ago, he started Ceronix in his garage. He soon hooked up with gaming legend and IGT founder Si Redd, providing monitors for Si's early video poker machines. Today, Ceronix monitors can be found in slot machines around the world.

Ceronix sports a 400,000 watt photovoltaic array on the rooftop of the manufacturing plant. During periods of peak electrical demand, excess generated electrical power is sold back to the utility (the meter actually runs backward) and taken in the form of credits which are then used to offset the cost of electric power when the photovoltaic output is less than the load.

from their own deep fissure well that can produce 90 gallons per minute. This well supplies water for landscape irrigation on the property. As part of this proprietary plumbing system for the property, Whitaker has spent $600,000 on a half-million gallon pond that includes a 200 feet long, four-feet deep recirculating stream filled with 80 tons of gravel. This stream provides biological filtration, something certainly appreciated by the several thousand Koi who inhabit the roughly one-half acre pond, complete with a small wood pier, an automatic fish-feeding machine, and a paddleboat. Because the pond is not lined, much of the well water as well as otherwise wasted rainfall run-off, is returned via percolation to underground aquifers. Ceronix consumes water, but with their percolation pond they also put water back into the system.

This is the kind of thinking that makes Don Whitaker a true geek hero (to me, anyway). Ceronix manufactures an undeniably excellent product but does so in an environmentally friendly manner. They also give great customer service (ask them about the $300 "Randy Fromm" kit of Ceronix spare parts that will enable you to repair hundreds of monitors) and provide a wonderful working environment for their employees. Ceronix also provides technical training for slot techs on Ceronix monitor repair.

For further information, contact:
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Phone:(530) 886-6400
Fax: (530) 888-1065
ceronix.com

Automatic insertion is the name of the game at Ceronix. Components arrive at the factory in "ammo pack" (top) "tape reel" or DIP "tubes." The third photograph shows the Dual, In-Line Package (DIP) insertion machine, where assembly begins.

A three-station assembly machine (r) grabs the components off the bulk packaging, stuffs them into the PCB, and cuts and clinches the component leads so they don't fall out of the board. From here, the printed circuit boards move to the wave soldering machine and from there, into a cleaning bath (made from biodegradable Simple Green solvent) to remove the solder flux. Ceronix PCBs are completely washable in soap and water. You can even put them in a dishwasher.
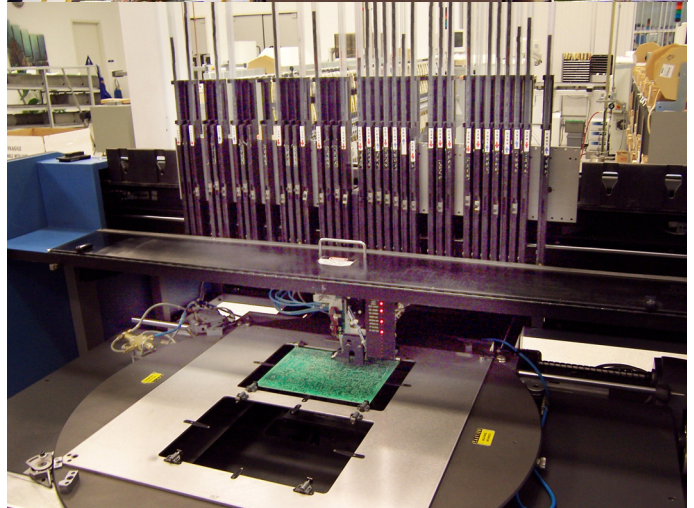
Casino Roulette
Steals the Show for Kimble

Kimble's new Casino Roulette received outstanding praise at this year's ICE show in London. The game is a single player virtual roulette, which allows all the betting options of a standard roulette table in a slot format. The game uses a random number generator to keeping the game playing at the same percentage as a roulette wheel. There is no percentage change so the player has all the same chances of winning they have at a live table.

From the operator's point of view, the game allows the operator total control of the betting limits, with options to set the limits on all types of bets, specific sections of the field and across the whole board. The speed of play can also be adjusted to suit players in different areas.

Another aspect of the game is that it stores the last 20 games in memory showing exactly what was bet on that spin of the wheel, the result and the time and date of the game.

With orders already taken at the show, Casino roulette looks to be a major success for Kimble this year.

Also on show was Kimble's new Hi-Low Poker and their Match and Win poker. Both play five-card draw poker with two jokers wild. However, both have different gamble features. Hi-Low is the familiar "higher or lower than the previous card" gamble. Match and Win Poker uses Kimble's very own unique Match and Win gamble feature which has proved a big success. Kimble will be installing a number of the Match and Win pokers in India in April.

Kimble also showed their Emerald Isle range of video slots which they are pushing in their home Irish market. Kimble have put together a range of high quality video slots at a rock bottom price with the games starting at €3890 for a slim-line chrome cabinet, 19" TFT monitor with touch screen and JCM EBA12PB2 bill acceptor as standard.

Kimble also had their bar top cabinet on display with a 14" TFT monitor, bill acceptor and coin handling. This proved very popular in particular with Irish operators

James Mc Cann, Managing Director

who visited the show.

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Co. Louth, Ireland
E-mail:kimble@iol.ie
Tel: +353 (0) 42 9336574
Fax: +353 (0) 42 9333251

Zendex Casino Video Gaming Board
Delivers a Rich Visual Gaming Experience

Zendex Corporation has announced a special purpose single board computer aimed specifically at the gaming market. The ZXE-855 is a full-function dedicated gaming platform that can deliver the rich visual gaming experience that people now expect in casinos. At the same time, it allows the system manufacturer to configure the board in order to optimize speed, power consumption or cost.

To allow a choice between performance and cost, many systems are designed with one or two processor choices. Zendex found a way to provide numerous speed, power consumption and cost options. For example, the ZXE-855 with low power Intel [INTL] Celeron 4 processor and Intel 855 chipset can be run at 600MHz for lower power consumption, lower temperature rise and higher reliability. Typical power consumption at 600MHz is 35W. Alternatively, the Intel P4 processor and 855 chipset will run at 2GHz for greater performance. Still other options are available to minimize system cost.

The highly-adaptable VGA video ports will drive two 1600 x 1200 resolution dis-plays. Behind the video outputs are dual VGA outputs with up to 64MB of shared memory. For graphically intensive and memory-hungry applications, the board can accommodate up to 1GB of DDR DRAM that is considered sufficient for 99% of all applications.

The regulatory agencies often demand that casino video games include redundant mass storage, and the ZXE-855 supports a wide array of mass storage devices. It features 2 UDMA 100 ATA channels supporting up to 4 ATA devices (i.e. 4 hard drives) or 4 Compact Flash memory type I headers on the ATA Bus. The ATA bus can also support an ATAPI CD ROM drive, Disk on Module (DoM) or Multi Media Card (MMC). There are also sockets for EPROM or other non-volatile memory devices.

Cooling fans are a problem in gaming applications. They are more failure-prone than non-mechanical devices and produce audible noise. Zendex designed the ZXE-855 for convection cooling (no fan) in all speed-power-cost configurations.

The ZXE-855 mates to a passive backplane, the ZXE-855BP. The backplane allows quick insertion and removal of the main gaming board and provides I/O connectors
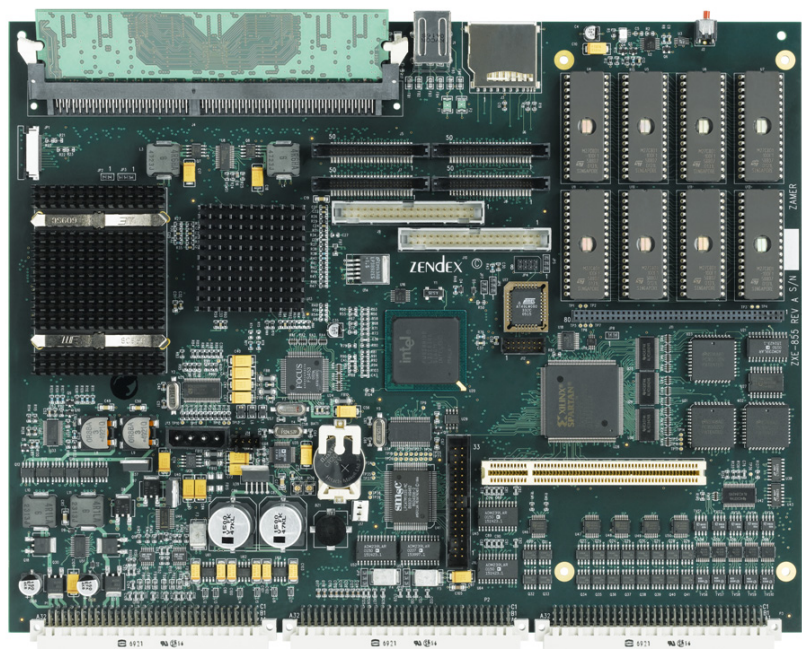
Zendex ZXE-855
Full function embedded gaming controller

- Intel® P4 M or Celeron M up to 2GHz
- Intel® 855 Chipset
- 6x USB 2.0 USB ports
- 400 MHz Front Side Bus
- 2 XGA video ports
- 5x RS-232 Serial Ports
- Full Passive I/O Backplane
- Low Profile, low noise, Low power
- Supports Windows® XP, 2000, XP Embedded and Linux
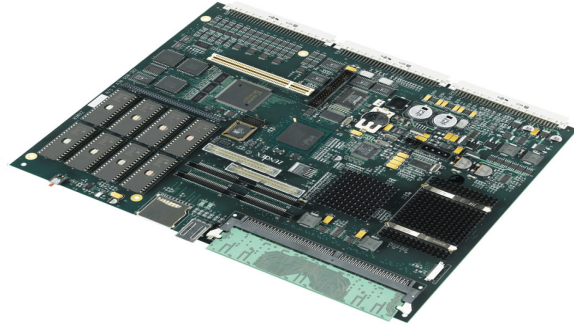
Zendex® has been building boards for the gaming industry for over 10 years. Leveraging 25 years in regulated industries Zendex® has designed the ZXE-855 to bring the latest technologies to the gaming market.

Using the Intel® 855 low power chipset (6-30 Watts) and proven Intel® Mobile CPU's, Zendex® has again proved why it is a leader in the regulated market.

Full list of functions:

- Intel® 855 chipset
- Intel Pentium® 4 M or Celeron® M up to 2GHz
- Celeron M CPU @ 600Mhz
- Up to 1GB with 1 DDR 184 Pin DIMM
- 2 UDMA 100 ATA channels supporting up to 4 ATA devices
- 4 Compact Flash type I/II headers (on ATA Bus)
- AC97® Stereo Audio out and line input
- 10/100 Ethernet
- 5x RS232 Serial Ports & 1 Parallel Port
- 6 USB2.0 ports

- 2x RS422 Serial Ports
- 1 TTL Serial Port
- 40 General Purpose inputs
- 40 General Purpose outputs
- All I/O available on passive Backplane
- 8 32Pin configurable DIP sockets for Memory; expandable to 24 with 16 Socket module
- Dual VGA 4x AGP Memory Shared up to 64MB, supports up to 1600x1200
- PS/2 Keyboard and Mouse support
- Backplane connection 3x 96 pin DIN
- Watchdog timer and thermal monitoring
- ITP700 (ICE) Debug Port
- Power Management Enhanced Intel SpeedStep® Technology, Deeper Sleep, ACPI
- Power 12V or 15V typical 35 Watts

Designed to Work with Linux, MS Windows 2000, XP and XP Embedded.

Also Available:
* Backplane: ZXE-855BP-A®
* Memory Expansion Module: ZXE-855MEM®

that allow the system to interface with bill acceptors, card readers, voucher printers, and monitors. The backplane is configured with numerous I/O ports including six USB 2.0 ports, one 10/100 Ethernet port, five RS-232 serial ports, two RS422 serial ports and one TTL serial port. In addition, the ZXE-855 main board includes 40 general purpose inputs and outputs.

The user has many operating system choices, including Microsoft [MSFT] Windows® XP, 2000, XP Embedded and Linux. Zendex can modify the proprietary BIOS software to suit the user's needs or to include additional security features.

Most computer systems provide only signal-level audio outputs which must be amplified before it can be applied to a speaker. The ZXE-855 provides an AC97® amplified stereo audio output which can be directly connected to speakers, saving the cost and complexity of external amplification.

An unusual feature not normally found on products like this is an on-board thermal monitor. While the board itself is designed to run 24/7 without fan cooling, the system configuration might include other heat-generating devices that could necessitate a fan. The on-board thermal sensor provides a digital temperature output which can be accessed over the Intranet via the 10/100MB/

sec Ethernet connector. A large array of games with this feature can be monitored from a single location.

The Ethernet interface allows similar games to be interconnected, so that one person can play against another, or against an entire room full of people. Also, the Ethernet interface enables remote system monitoring and management. In the event of a problem with any game, a warning can appear at a monitoring location.

The ZXE-855 is designed to operate from a single +12V or +15V supply. Power consumption is nominally 35W, and varies by configuration. The ZXE-855 measures 12" x 9-1/4" x 2". The low profile is especially useful in desktop games, where cabinet size is limited.

Commenting on the new board, Howard Czapla, Zendex CEO, said "We designed this board based on 10 years of experience building similar boards for the gaming industry. It includes the features that most gaming system manufacturers are looking for. We anticipate that companies us-

ing the ZXE-855 board will have a significant advantage over our competitors."

Zendex is a full-service provider of PC/104+ and other single board computers, embedded processor boards, multi-function boards, CIMbus, Multibus and iSBX modules, industrial enclosures and custom systems. Zendex recently celebrated 25 years in the embedded systems industry.

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Don't Throw Your Ballast Overboard

Sometimes, you just don't care how something works, you just want to fix it and be done with it. The electronic ballasts that IGT uses fail with awesome regularity. That's great news for slot techs 'cause it adds to "job security." The floor tech gets to diagnose and replace the unit while the bench tech gets to repair it.

I hope you haven't been throwing these units in the trash (in California, it's no longer permissible to toss printed circuit boards in the trash. They have to go to an electronics recycler). I hope instead, that you've been tossing them in a box on the "bad" shelf. If you have, order a small handful of replacement components (a .01 µf, 400 volt polystyrene capacitor, a .033 µf, 400 volt polystyrene capacitor and a pair of switching transistors, TIP31C - 100V, 3A - or equivalent) and, when you have a dozen bad ones, drag 'em out and fix 'em.

Ok, I'll grant you that a replacement ballast is only ten bucks but a rebuild kit from Suzo-Happ (70-1337-00) is only $2.50 and it takes just seven or eight minutes to open the unit, remove and replace the parts and put it back together again. Unless you're really strapped for time, it's practical to repair the ballasts. It's also great way for novice techs to practice soldering and have the rewarding experience of actually fixing something without having to worry about ruining it in the process. **- STM**

C4
.01µf(103k)
400V

2X TIP31C

C3
.033µf(333k)
400V

These are the parts that fail

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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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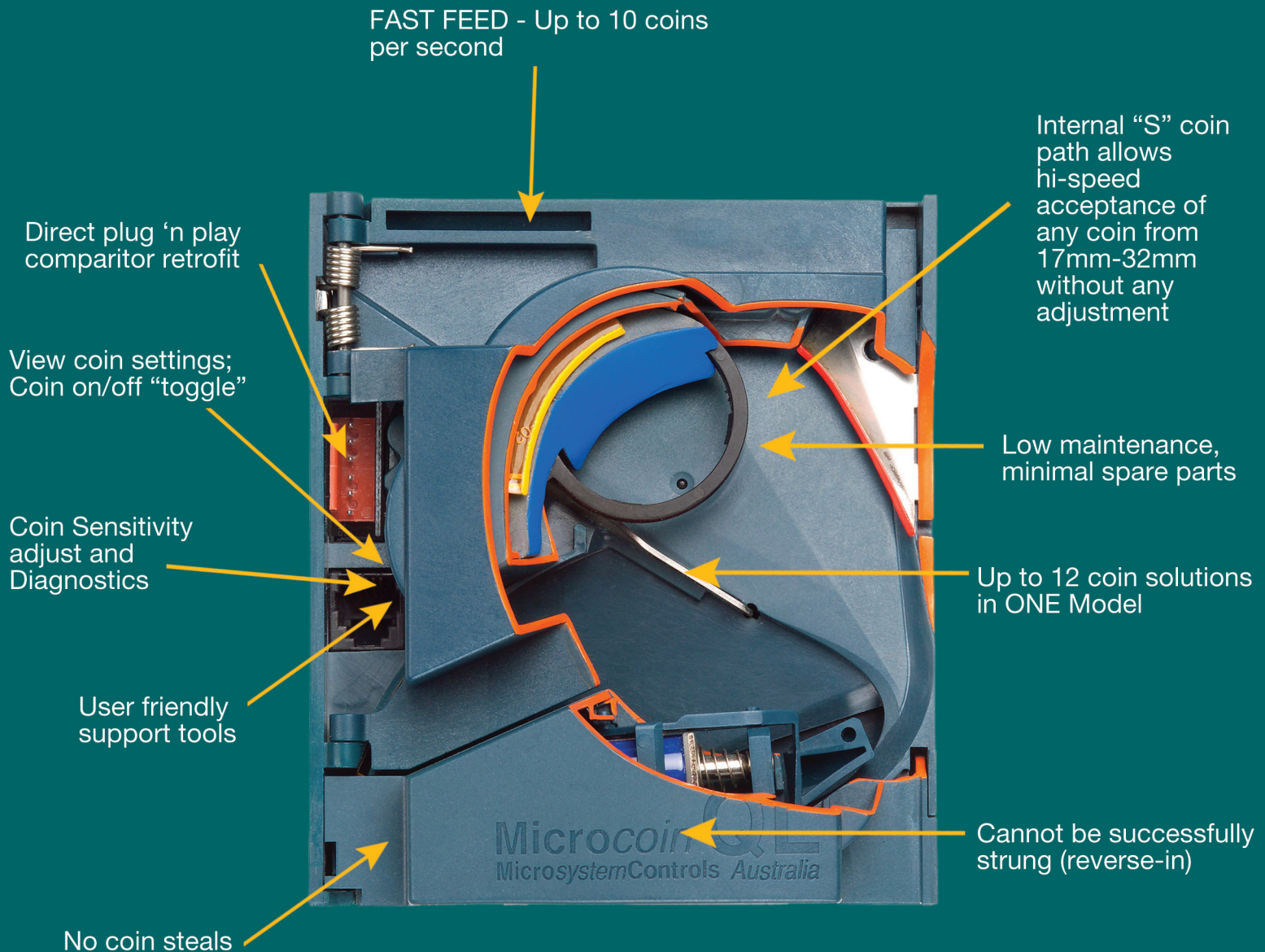**[ ] 2 year subscription, domestic**
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Up to 12 coin solutions in ONE Model

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