July 2013

Slot Tech Magazine

Slot Machine Technology for the International Casino & Gaming Industry

Epic 950 Basics

Slot Tech Training in El Cajon, CA & Lawton, OK

Quick & Simple Slot Machine Repairs from Pat Porath

Slot Math

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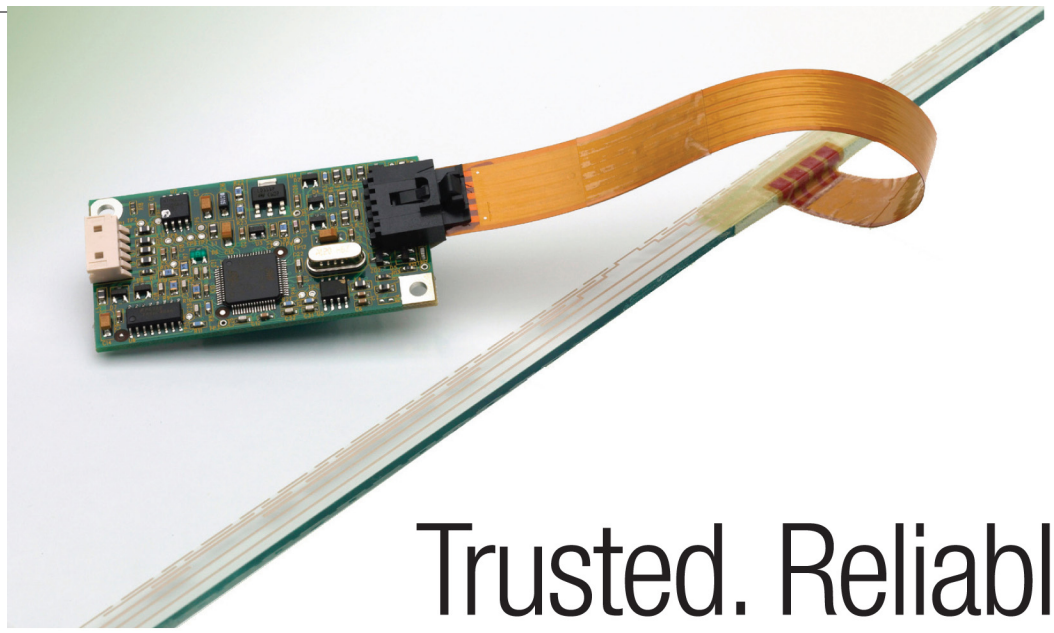
Slot Tech Magazine



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Slot Tech Magazine

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Randy Fromm

Dear Friends,

I'd like to comment on the "Women in Gaming" award/recognition/seminar programs that are popping up all over in the trade journals and at gaming seminars. At a time in Western Society, when we're trying so desperately to EQUALIZE our population and recognize everyone as simply a fellow citizen and/or human being (without regard to race, nationality, religion, blah, blah, blah) why would you want to single out women as a group of people for a "special award?" I think it's insulting. It's as if you are saying to them "You're not good enough to compete in the broad arena of the casino industry so here's a unique award that's based primarily upon your chromosomes. Secondarily, we'll consider your qualifications and your performance." That's bullshit. Women in gaming are exactly the same as men in gaming. There is ZERO difference.

I realize that Hollywood has their "Best Actor" and "Best Actress" Academy Awards but these awards also reflect old, twentieth-century thinking (established in 1928). Female thespians now refer to themselves as "actors" (rather than "actress") in a effort to move away from the distinction of gender in the workplace. And guess what, it's not even legal to advertise "Girl Wanted" for employment so why is it acceptable to advertise "girl wanted" (or "woman wanted" or "female wanted") because you want to hand out some sort of award but only to a female applicant? Just who is stroking what and why?

Why stop there? Why not extend this whole awards scheme to other groups of people working in the casino industry? Let's see . . . How about BMI? Surely those with a high Body Mass Index deserve special recognition. It must be just as challenging to be a large person working in a casino as it is to be a female. How about people of color? How about Jews? When I was a boy, my father received the "Ner Tamid" award from the Boy Scouts, a special award that was only given to a Jew. He never did anything "Jewish" while in scouting, he just happened to be an awesome scout leader and a Jew. Nobody else was even considered for the award as he was the only Jewish scout leader. That's not an award I'd be interested in accepting. I'd have turned it down with thanks but without gratitude for the consideration.

So, I put it to you: If you're the type that looks for personal recognition with the ephemera of award certificates, pins, plaques, medals and statuettes that go along with it (Look up. Do you have an "I love ME" wall in your office or shop, covered with diplomas and/or certificates of completion? If so, I'm talkin' to YOU) would you rather have these awards based solely upon your personal achievements in the broad arena of competition or would your rather be given a helping-hand by the elimination of your competition through some sort of non-meritorious selection process? I can easily imagine a "Slot Tech of the Year" award (I wish there was one). I can't imagine a "Male Slot Tech of the Year" award or a "Female Slot Tech of the Year" award. I can't imagine who would want it.

Randy Fromm

Publisher
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Randy Fromm's
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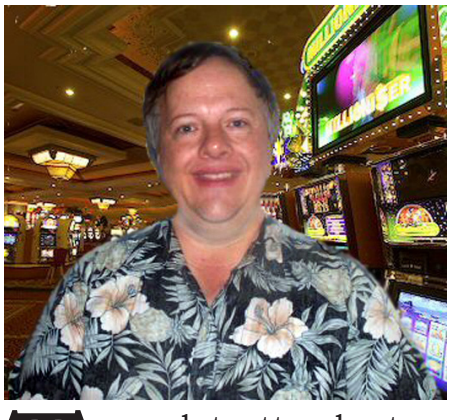
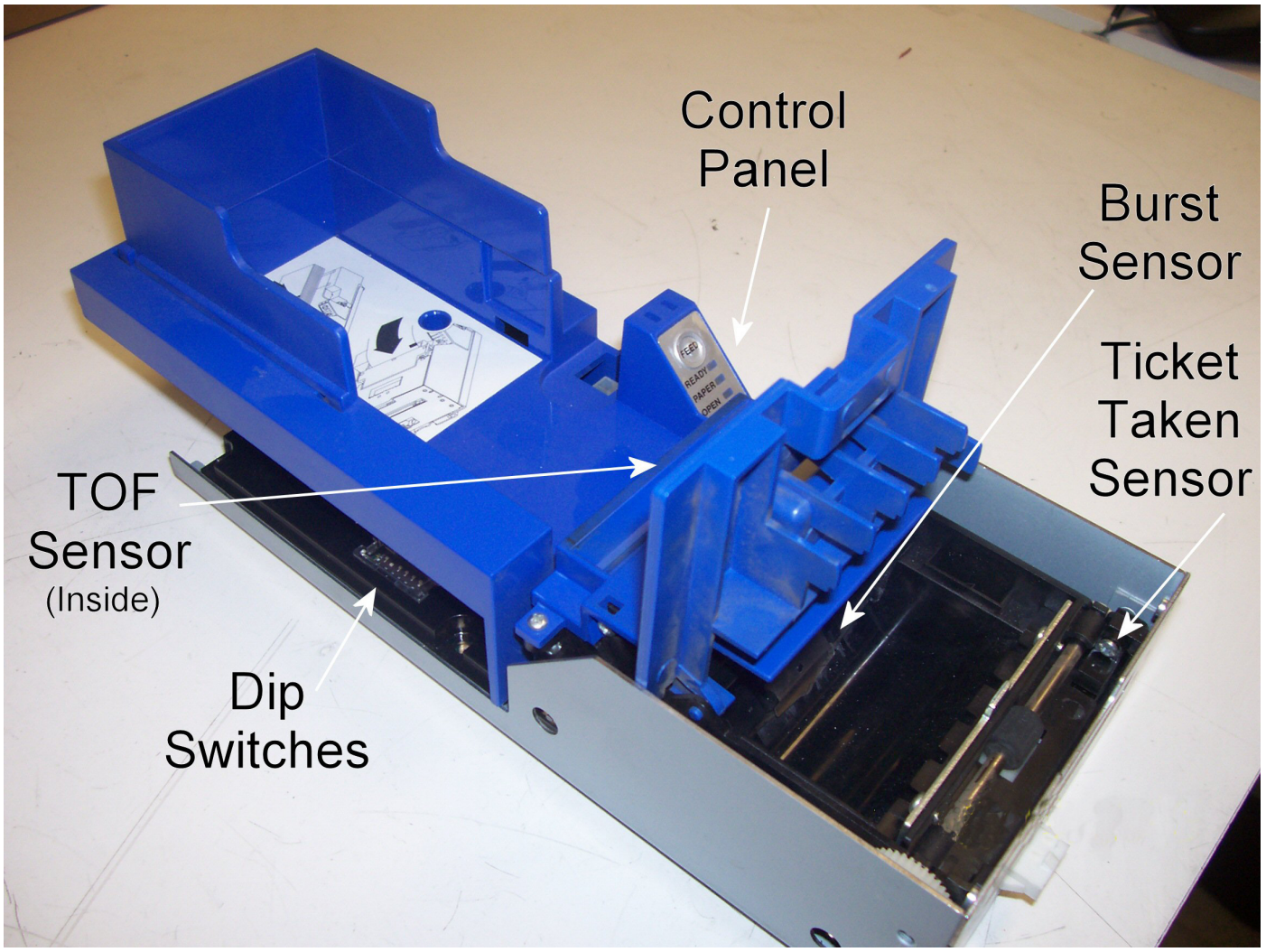


An Epic Printer

By Vic Fortenbach

To a slot attendant, a printer is just part of a slot machine. They fill it with paper, feed the paper into the slot and fix any minor paper jams that might occur. Occasionally, the slot attendants want us technicians to refill the printer ink.

To a slot machine technician, the printer is much more. In fact, the Epic 950 printer, manufactured by Transact Technologies is no newcomer to the gaming world. Transact Technologies first gaming printer was the Ithaca 750 printer followed by the Ithaca 850 and now the Epic 950 printer. The Ithaca 750 is over 10 years old and a workhorse of a printer. We still have over 30 Ithaca 750 printers working and trouble free on our casino floor. While the Epic 950 printer is the newest printer, its reliability and trouble free operation is matched with the Ithaca 750 printer. The features of the Epic 950 printer include two stepper motors instead of just one to move the ticket paper through the printer. If the second steeper motor is not turning, the paper ticket will never be presented to the player. No more long tails of blank tick-



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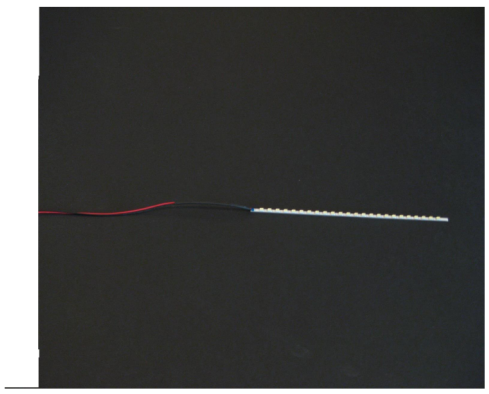

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ets on the floor, from a runaway printer due to a sensor malfunction. Four paper sensors instead of the normal three. A ticket burst feature that actually separates the printed ticket at the perforation inside the printer before presenting it to the casino guest.

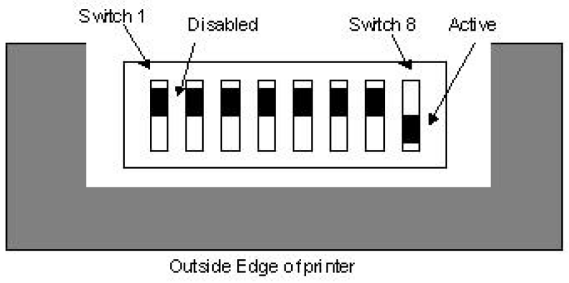
For visual troubleshooting, the printer's keypad has a feed button and four LED indicators. These LED indicators are not your standard LEDs. They work together to give the slot technician an edge toward troubleshooting the printer. Normally, a printer LED will illuminate to indicate a problem such as the fault LED it lights for a printer fault. Not on the Epic 950 printer. A printer head temperature error will light the ready LED AND the blink the fault LED. This is LED indication to the extreme! There are ten different on/off indications and three different blinking LED speeds possible with these four LEDs and the front bezel. The printer status table lists all of the troubleshooting LED combinations.

Overall, the Epic 950 printer is trouble free, but when there is a problem, usually a blast of compressed air or using a cotton swab gets the printer and the slot machine back on line. Troubleshooting the Epic 950 printer on the casino floor is easy and can be completed by using just your eyes and some basic printer knowledge. Actual part replacement should be completed on the bench and can be completed with just a #2 Phillips screwdriver and some needle nosed pliers.

Inside the Epic 950 printer are three optical sensors that detect the ticket paper as its various points. The sensors are named in order of paper travel, Top Of Form (TOF), ticket burst and ticket taken sensors. The first sensor encountered by the paper is the TOF sensor. This sensor is located just inside the lip of the paper-in slot on the top of the printer. The TOF sensor detects the black index mark on the ticket papers right edge. A bad TOF sensor can be isolated when the paper is not drawn into the printer after being inserted into the paper slot on the top of the printer. The feed button can be pushed to draw the paper into the printer but because the bad TOF sensor does not "see" the black index mark, the motor will continue to run, bunching up the paper inside the printer. When the index mark is detected by a working TOF sensor, the first stepper motor, called the ticket feed motor is activated. The rubber rollers connected to this motor grab the paper and as the motor turns, moving the paper through the printer to line up the paper's black index mark with the TOF sensor.

The second sensor next in line is the ticket burst sensor. This burst sensor is located behind the silver plate in the inside middle of the printer. This plate can be easily seen by lifting up the blue hinged top cover. This

Switch 1 is the furthest to the rear of the printer. The Active position is toward the outside edge of the printer.



SW-1	Reserved and must be in the Disabled position. If activated, the printer will be held in reset.
SW-2	Configures Ticket Low. The Disabled position prevents ticket low from being detected.
SW-3	Activates Demo mode. It must be in the Disabled position for normal operation.
SW-4	Activates the Error log if enabled in <por.ini> file. This is useful for debugging but should not be on by default.
SW-5	Activates Com Save if enabled in <por.ini> file. This is also a debugging feature and will be used with future TransAct tools to help debug printer operations.
SW-6	Reserved
SW-7	Activates the Smart Suite features. Must be active to use the status features of the Bench Test utility. Must be active on Bally Alpha platforms with 3.17OS or grater or if you receive constant "Printer COMM Error".
SW-8	Activates 2-color operation (color ticket media required)

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silver metal plate has a sharp point on the bottom edge to "burst" or separate the paper at its perforation. Once the paper edge has crossed over the burst sensor, the second ticket transport motor starts to rotate at a speed a bit faster than the feed motor and grabs the paper. This increases the tension on the moving paper to burst or separate the ticket paper at its perforation. Once the paper has been separated, the second motor continues to turn and an additional set of rollers grabs the paper and moves it through the printer to the third sensor, the "ticket taken sensor" and out to the guest.

A telltale sign that the burst sensor is bad (or the ticket paper has been inserted incorrectly) is that the paper does not stop and also bunches up inside the printer like a bad TOF sensor. The bunching up of the paper is not a blockage in the paper path but rather caused by the second stepper motor since is not turning due to a bad burst sensor.

Once the ticket taken sensor is blocked by the ticket paper, the printer's control board turns off the transport motor. The paper snout (the bezel) of the Epic 950 printer has been designed to be just long enough so that a casino guest cannot pull on the paper until all of the printing has been completed and the ticket has been burst at its perforation. As the paper is presented to the guest, the printer's blue bezel will flash, drawing attention to the ticket in waiting. When this sensor fails, the printer's front bezel will continually flash, even though there is no paper blocking this sensor.

On our Bally Alpha machines, the printer bezel appears to be flashing without a ticket in waiting. At first we thought it to be a bad sensor but in fact it was just dust blocking this sensor. However, because this sensor is mounted horizontally, with a depressed area where the phototransistor and the plastic of the sensor meet, dirt accumulates in this area. A simple blowing with compressed air will usually dislodge the dirt.

The Epic 950 printer has a bank of eight dip switches, but only switches 2, 7 and 8 have useful functions. Dip switch number 2 controls the best feature of any printer, the ability to turn off the "paper low" candle light soft tilt function on the slot machine. This feature can be used if the casino's ticket paper is not reflective enough to trigger the paper low sensor on the printer. Pretty cool huh?

Dip switch #7 has two functions. On a Bally Alpha slot machine with an operating system of 3.17 or higher, this switch must be on to avoid any printer COMM errors. This switch also activates the

Printer Status LEDs

The printer has been outfitted with a LED panel system that provides the condition of the printer by using solid or blinking status LEDs to communicate status information. The following table lists the different LED states for specific printer conditions.

Bezel Status LampThe printer's bezel also displays certain printer status information. See the table below.

Condition	Ready LED	Paper LED	Open LED	Fault LED
Unit Ready	On	Off	Off	Off
Cover Open	On	Off	On	Off
Chassis Open	On	Off	Blink	Off
Ticket Out	On	On	Off	Off
Ticket Low	On	Blink	Off	Off
Head Temp Error	Blink	Off	Off	Blink
Paper Jam	On	Off	Off	Blink
Ram Error	2-Blink	Off	Off	On
Boot Load Mode	Blink	Off	Off	On
Config Mode	Blink	Off	Off	Off

Bezel Status Lamp

The printer's bezel also displays certain printer status information. See the table below.

Steady	Blinking Rapidly	Blinking Medium	Blinking Slowly
Online and Ready	Ticket is being printed Ticket in ticket taken sensor	Ticket low Chassis open Cover open	Ticket not loaded (TOF) Ticket jam error

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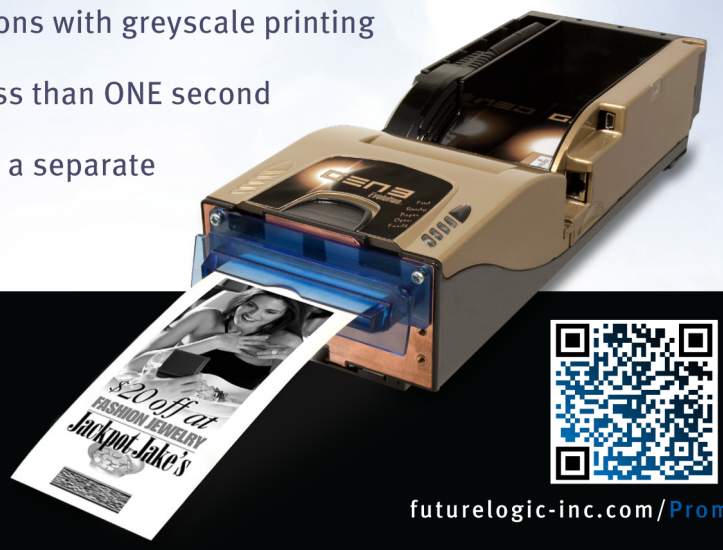

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smart suite features of the bench test utility when bench testing this printer. Dip switch number 8 activates the two color printing option. Of course, you will have to have unique two color thermal paper to use this function.

As I mentioned previously, the Epic 950 printer has two stepper motors. These stepper motors are identical to the motors used in positioning the reels on a slot machine, only smaller-much smaller. These motors are both physically the same and can be interchanged. There is one very minor difference. On the printer's control board, the motors connect into different receptacles, one is white and the other is white with a black sharpie mark. When you replace a motor, mark the plug of the motor accordingly so the next technician that has to replace a motor won't get frustrated when the motor that presents the ticket runs when the paper is inserted into the printer.

While most printers have status LEDs, the Epic 950 printer goes a step farther by flashing two or more the LEDs to better guide the technician to the problem. The four status LEDs on the printer do give the slot technician a starting point as to what the problem may be.

The printer has been outfitted with a LED panel system that provides the condition of the printer by using solid or blinking status LEDs to communicate status information. The following table lists the different LED states for specific conditions.

With any printer, a visual inspection and a light cleaning to remove paper fibers from the sensors is often all that is required to keep the printer functioning.

Vic Fortenbach
vfortenbach@slot-techs.com

For schematic diagrams, service manuals, software, etc., visit the Slot Technical FTP Server at slot-tech.com

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Slot Tech Event

Training With My Homeboys

I am fortunate to live in Southern California, in San Diego County. We have great climate, clean and sandy beaches, the Taylor Guitar factory is here, we have breweries, we have Sea World, we have an extraordinary zoo and we have a dozen casinos. My friends at nearby Sycuan Casino requested training for some new slot techs and offered me the classroom space if I wanted to invite anyone else to the event (three folks from Bear River Casino joined us). Naturally, I jumped at the chance to hold a class without having to fly across the country to do it. I actually got to return home every night to be with my beloved ~~dogs~~ wife. -**rf**

Miguel Trujillo and Aaron Pepetone (Bear River Casino) work on the digital lab project.

Attending the class from Sycuan Casino were Adela Correa (arguably "homegirl rather than homeboy), Kevin King, Joseph Semaia, and Louis Carrion. Attending from Bear River Casino were Miguel Trujillo, Aaron Pepetone and Jai Kibby.

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Quick & Simple Repairs #97

By Pat Porath

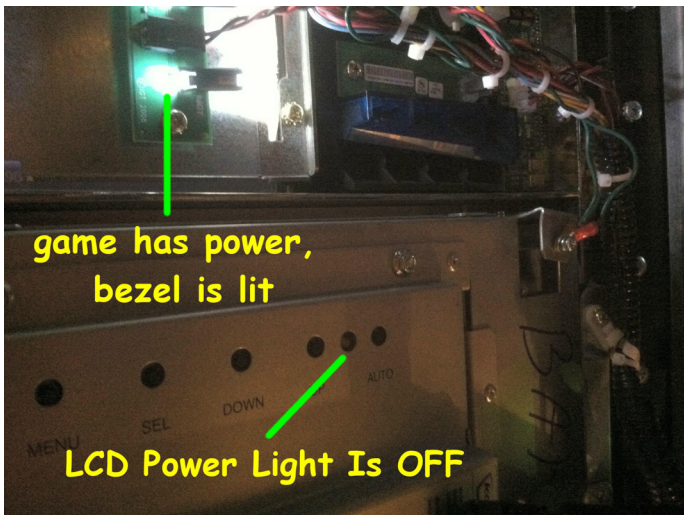
IGT AVP Bar Top Game, Black LCD

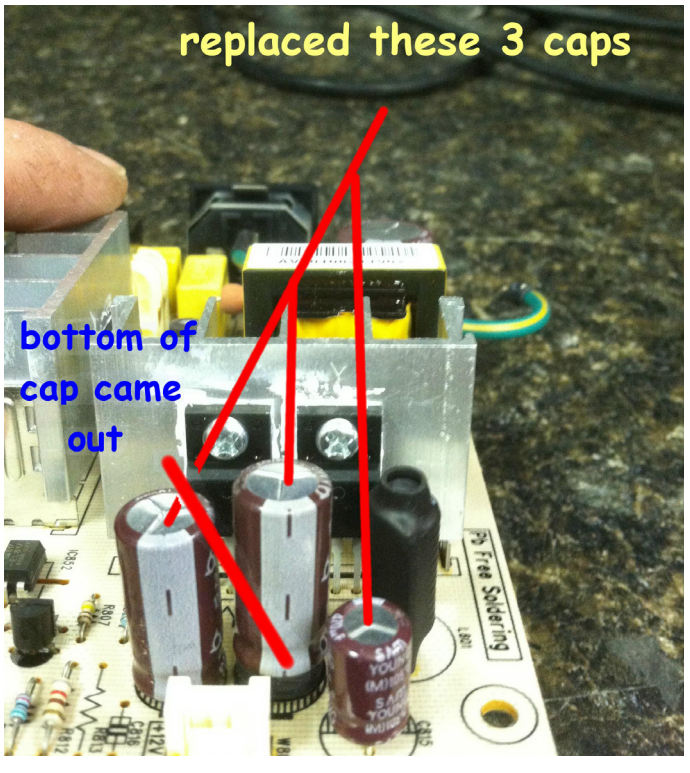
While making a round on the gaming floor I came across an IGT AVP multi-game bar top that had a totally black LCD. When taking a look at the inside, even the LCD power LED was totally black. Could it be a loose LCD power cord, a bad game power supply, bad LCD power supply, a loose connection somewhere?

At first I wasn't sure where to start but had to start somewhere. The 120 vac power cord to the LCD was unplugged for a few seconds, then plugged back in while looking at the power LED on the LCD. Absolutely no sign of power at all! The light didn't even flicker for a half second, even though the rest of the game did have power (the bill acceptor bezel was lit, the printer bezel was lit and the interior game light was on).

What about a good old fashioned power cycle of the game? During the reboot process, I did hear typical "IGT AVP" startup sounds; the bill acceptor cycled normally too. All the while still no sign of life from the LCD. It was original. What the . . .? How can these power supply boards be different? The exterior of both LCDs looked exactly the same to me. Now how can I repair the game?

When taking a closer look at the power supply board on the original bad unit, one of the capacitors was domed. In addition, the bottom plug was starting to come out of it. No doubt a bad cap. So off to the tech shop I went with intentions of replacing a few caps. The obvious bad cap was removed along with two others that were in the area. If one of them was bad, maybe the other two were starting to go bad as well.





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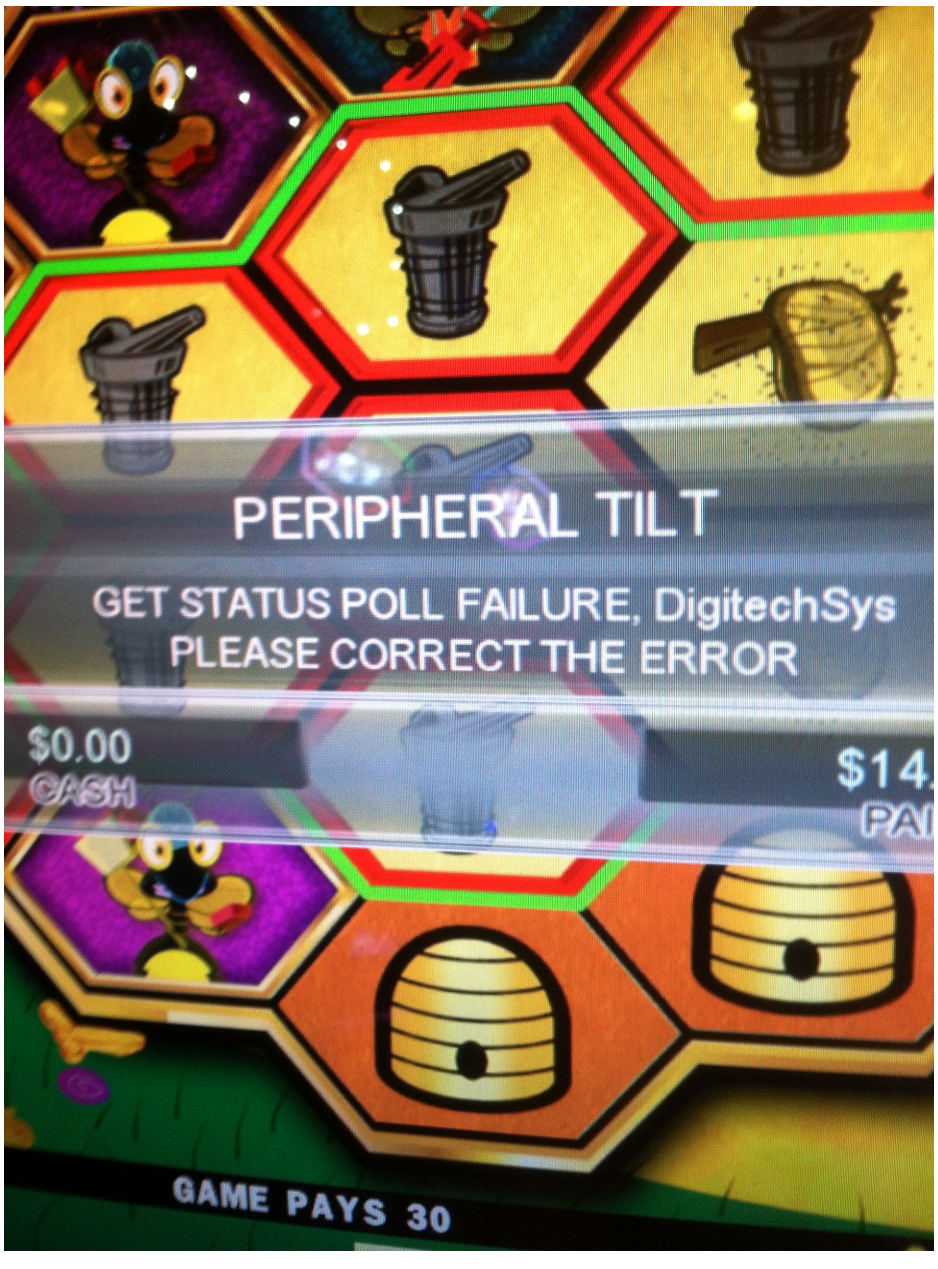
All three caps were replaced with the same value and the LCD was put back together. Now it was ready for testing (with fingers crossed because I am not a bench tech and I don't solder very often anymore). Game power was turned on and bingo! The monitor lit up perfectly. The game booted up and was working again. Simply and easily replacing three capacitors on the power supply board of the LCD repaired the game. Note: Capacitors replaced were C813, C814, and C815.

IGT AVP 3.0 "Peripheral tilt"

I received a call for a "Peripheral tilt" on an IGT AVP 3.0 game. On the screen, it showed "PERIPHERAL TILT, get status poll failure, Digitech system. Not exactly sure what everything meant, I did know that a touch screen was a "peripheral device" and "Digitech system" was the brand of touch screen controller. Connections were checked on the main screen, such as video, power and such. Everything looked nice and snug, also, nothing appeared to be pinched in the door frame area. So the game was power cycled to see if the error reappeared. After boot up all of the errors cleared. It looked like a simple reboot did the trick this time.

WMS Bluebird Dim Belly Light

A co-worker was telling me about a WMS Bluebird game in which the belly light, a T6-6 watt fluorescent tube, would only last a few days then it would need replacing. We know that under normal circumstances, fluorescent tubes can last for years. When looking at the belly glass, it was quite a bit dimmer than the game next door. Another bulb was put in for the heck of it, and the same thing. It was kind of dim. The ballast was examined but it was, in fact, rated the correct wattage. We have had the games for a few years or so, maybe the ballast was going bad. It was disconnected and reconnected only to have the same result. A spare ballast was installed, also making sure it was rated for an output of 6 watts. When power was applied the bulb lit up beautifully. The original ballast was starting to go bad.



Editor's Note: This illustrates the importance of tracking machine repairs. It's as simple as maintaining the "MEAL" book (Machine Entry And Log)-sort of an odd name-that should be in each and every machine. There are only two components to the system: The lamp and the ballast. If the MEAL book shows multiple lamp replacements, let's not waste any more of the casino's money on lamps. This is one of the places that competent slot techs really "shine." A good tech makes a point of being aware of EVERYTHING that pertains to the "normal" operation of the casino (not just the machines themselves) from a technical standpoint. Weird sh*t calls for YOUR intervention to make things right because nobody else knows what the Hell is going on.

Aristocrat Verve-No COM

We were doing an install of a bank of four, Aristocrat Verve "Superman" (similar model game as "Tarzan"). When there is a yellow border around the Oasis Sentinel III, there is a GAME TO SENTINAL communication error. When a red border appears on the Oasis display, it may be a SENTINAL TO SYSTEM error, such as a fiber converter down or something like that. With this game (yellow border) options were looked at such as SPC board address set to 1. Connections were checked next, the interface cable from the Sentinel to the SPC board was connected and all three cables were connected at the SPC board (interface cable from Sentinel, power, and interface cable from game). The Sentinel was rebooted (along with the SPC board) but neither helped. The "slot mast ID number" was double checked, which was correct. As the SPC board was examined more closely, the problem was found. Somehow the interface cable FROM the Sentinel was plugged in backwards! After it was put on correctly COM was established.

Bally Alpha 2 Locking Up For Hand Pays

I received a call about a Bally Alpha 2 "U Spin" game that locked up for three small hand pays. Instead of printing a ticket, it went into jackpot hand pay mode. To make sure

the game did have a problem, two small-amount tickets were used for testing. Sure enough, after the nine-cent ticket was inserted and the cash out button pressed, it did indeed lock up for a hand pay. The main door was opened up and closed to see if the Oasis Sentinel II responded with a corresponding door signal on the display. Since it did read a door OPEN and CLOSED properly, I knew I had game TO Sentinel communication. Maybe the Sentinel and or game needed to be rebooted? Very shortly after a Sentinel power cycle, the correct DPU number appeared on the Oasis display. This indicated good communication FROM the Sentinel TO the Oasis System. Game options were checked such as "validation enhanced," "Ithaca 950 printer" was selected, "SAS Primary" was selected for communication, and so on. Everything looked good as far as I could see. Even three test tickets were printed from the game. What was left? Well, about the only thing that I could come up with (after giving the game an evil stare) was to look at all of the Oasis Global settings. A bit deep into selections was an option set "TICKETS NO." It is suppose to be set "TICKETS OK" so I set it accordingly. Once again a ticket was inserted to see if it would print instead of the game locking up. YES! A cash out ticket did print. It was inserted once again, and it printed again…finally! Only because an Oasis Global option was set incorrectly, the game would not print out a ticket.

Bally Cinevision Wouldn't Cash Out Credits

After opening up the door and removing both the plastic and metal cover, it was obviously a bad micro switch in the cash out button. While the customer was waiting for her credits to cash out, I quickly looked to see if I had a micro switch in my tool pouch. Which I did not, I only had one of the bill acceptor door type that wouldn't work. Swapping connectors with the service button, I thought it would cash out the credits. The game doesn't know which physical button is which and only a "working" switch would work. The connectors reached and it would have worked except the darn service button was very sticky and did not work either. So much for that plan, get the game to print a ticket for the customer, then replace the bad switch. I called the slot attendant back over to the game to have a cash pay done so the customer could get her money faster than me running to our shop, then replacing the parts. Two spare micro switches were retrieved from the shop and installed into the game. The service button was cleaned up a bit, now both the cash button and service button worked, verified by "button test" in diagnostics. Since I was in the area of "button diagnostics," the rest of the player buttons were tested too. Now ALL of the player buttons tested A-OK.

- **Pat Porath**
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Slot Tech Event

Training at Apache Casino Lawton, Oklahoma

Oklahoma was making the news big time in the first weeks of June, 2013. Tornadoes slammed into the state with the fury that always accompanies them. The week before I was scheduled to train at the Apache Casino Hotel in Lawton, Oklahoma, I received an e-mail from a friend, begging me to reconsider. Actually, it was really ju two words: Don't go!

But what the heck? This is the casino business anyway so I took a gamble on good weather (at the very least, non-tornadic weather) and flew into the cutest little airport I've ever been to: Lawton, Oklahoma. The weather "issue" was actually in Dallas, and we were 90 minutes late getting in but to the credit of American Airlines and Hertz, they both did a great job of getting me to the hotel, long after the midnight hour. Whew!

Honestly, this is a nice casino with some 800+ machines. It was busy as heck the entire week I was there for the class, which was on the subjects of power supply and LCD monitor repair. Although the class was intended for slot techs without any previous electronics training, I was really happy to see that they have one, really good bench tech (James) who will be able to guide the other techs through their repairs, now that they know the basics of electronic troubleshooting and repair. **-rf**

Attending the class at Apache Casino Hotel in Lawton were both slot techs and gaming regulators. I have to give props to the gaming regulators as they actually paid attention and learned electronics!

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The Mathematical Configuration of Paylines - Part 1

by Catalin Barboianu

In the last decade, mathematics has been taken more and more seriously into account in gambling, as being the essence that governs the functionality of games of chance and the only rigorous tool providing information on optimal play, where possible.

Also in slots, there is mathematics behind the sparkling machines, and many people will be surprised to find that the mathematical models around which a slot machine is developed belong not only to Combinatorics, Probability Theory, or Statistics, but also to other mathematical domains such as Topology.

The design of slot machines can be of any complexity with regard to both interface and case – and the models on the market exhibit this complexity. Of all physical parts, the interface is the most important with respect to the mathematical modeling, as it shows the machine in action, its outcomes, the game rules, and how these rules are applied in actual practice. When we talk about the configuration of a slot machine, we actually refer only to the technical component of its design that characterizes its interface, in its essential elements, and relations between them that are indispensable to a rigorous mathematical model – that is shape, topology, arrangement, and cardinality. There are the parameters of the mathematical models of this configuration in slot producers' hands that generate the wide diversity of the slot games wordwide.

The configuration of a slot machine is specified by the configuration of its display and the configuration of its reels. Lines and paylines belong to the former and in this article I will talk about the mathematical configuration of the display.

The display of a slot machine shows the outcomes of the reels in groups of visible stops (visible stop refers to a unit part of a reel holding one symbol, visible through its window after the spin; a window can show one or more stops) having a certain shape and arrangement. It also points out the ways (rules) the combinations of outcomes can turn into winning combinations.

The most natural and simplest mathematical representation of the configuration of the display is the Cartesian grid of integers, where the grid?s points stand for the reel

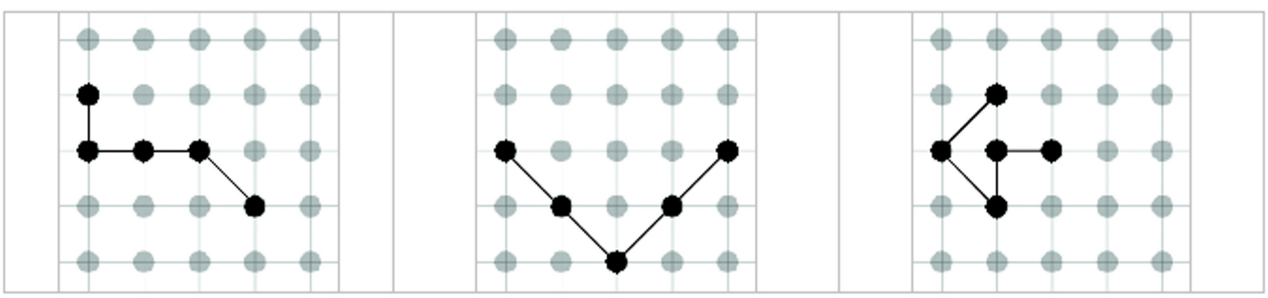

Figure 1. Examples of lines of length 5 in a grid

stops. Another alternative is to represent the configuration of the display as a graph. However, given the limited applicability of the theoretical results (the model provides us only with the number of all possible lines of a particular type, and only few features of the lines count toward probability calculus), the Cartesian grid is preferable due to the higher difficulty of working with graph theory.

The mathematical setting in a Cartesian grid starts with defining the basic terms of distance between two points on an axis, the neighboring of two points, and the vicinity of a point. These definitions uses a basic discrete metrical topology. Then, the main notion of line in a grid is defined as a set of minimum tree neighboring points. The cardinality of this set is called the length of that line (see figure 1, Examples of lines of length 5 in a grid).

A line in a grid is a finite set of points that can be connected through a path linking successively neighboring points of that set. Although the line was defined in a sequential manner, which involves a direction of walking through its points, we are interested in the line only as a set of points, regardless of the possible paths through which its points can be linked. Therefore a line has a connectivity property, not in a continuous sense, but in a discrete one (through the neighboring property). Although a line can be "walked" in several ways, this has no geometrical or combinatorial interpretations, but only topological.

The terminology used in this model complies in big part with the common language of slots.

The main properties of a line, having a geometrical analogue, are horizontality (when line's points all have the same coordinate on the y-axis), verticality (when line's points all have the same coordinate on the x-axis), and obliquity (when the absolute value of the difference of the coordinates of any two consecutive points of the line is 1 on both axes). A line is said to be broken if it is not horizontal, vertical, or oblique.

A line is called transversal for a finite set if it is included in the set and contains two points from

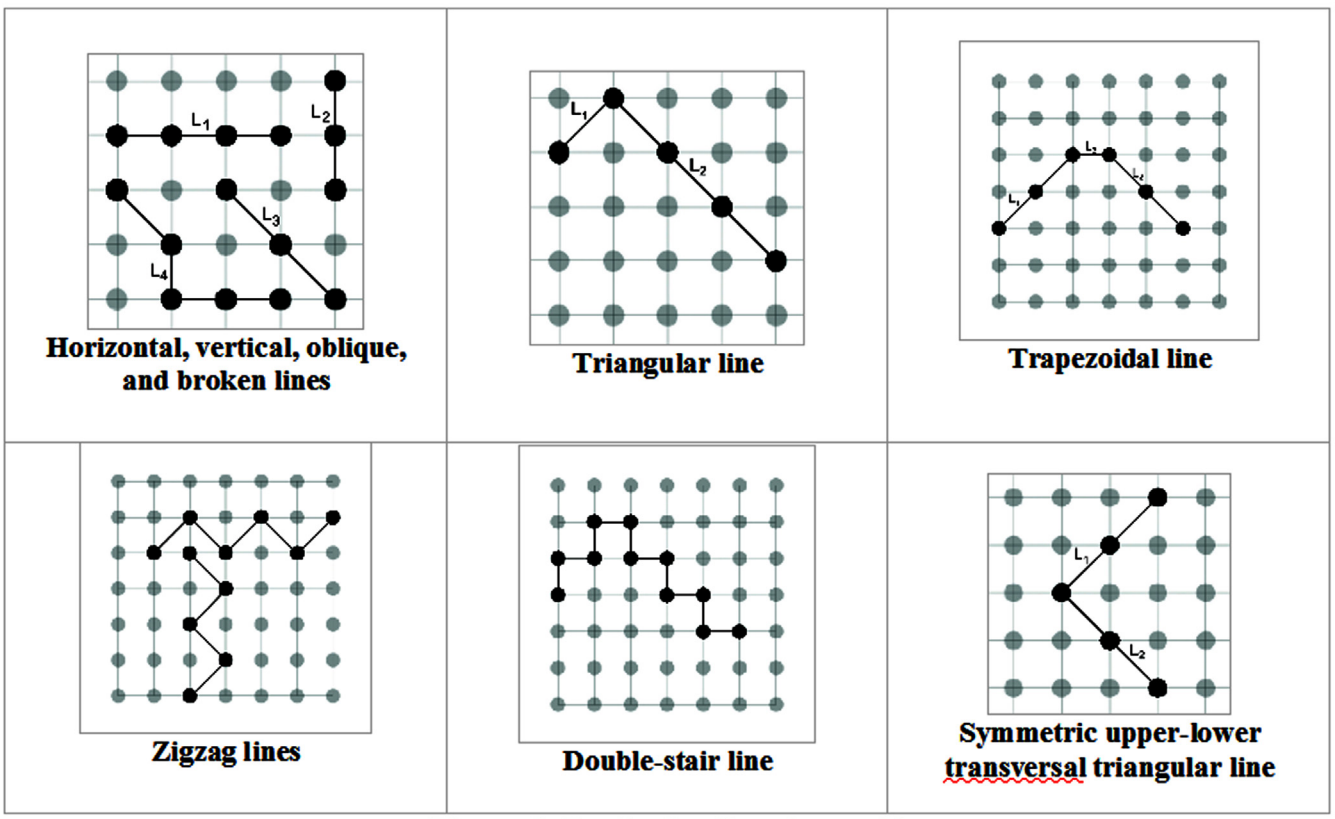

Figure 2. Particular lines in a grid

two opposite margins of that set (like upper and lower, or left and right margins).

Symmetry is also defined in a Cartesian grid only through means specific to the discrete space within which we work – symmetry of a point with respect to another, symmetry of a point with respect to a horizontal or vertical line, and then a symmetric set.

As for more complex shapes, lines can be triangular, trapezoidal, stair or double-stair, zigzag, etc. All these types of lines are defined through properties holding in the same Cartesian grid. In figure 2 are some examples of such particular lines in a grid, Horizontal, vertical, oblique, and broken lines, Triangular line, Trapezoidal line, Zigzag lines, Double-stair line, Symmetric upper-lower transversal triangular line.

With these main notions rigorously established, we can move to the mathematical object representing the display of a slot machine, namely the rectangular grid:

A finite subset R of the Cartesian grid is called rectangular grid if there exist m horizontal lines of the same length n, with m, n > 1, such that R is the union of these m lines and and:

a) the m lines are distanced at 1 from each other;

b) the m lines are left or right aligned.

m x n is called the size of the rectangular grid R (which is also called an m x n-size rectangle or a rectangle of m rows and n columns).
(An equivalent definition is obtained by taking vertical lines instead of horizontal and change the alignment to up or down at condition b).)

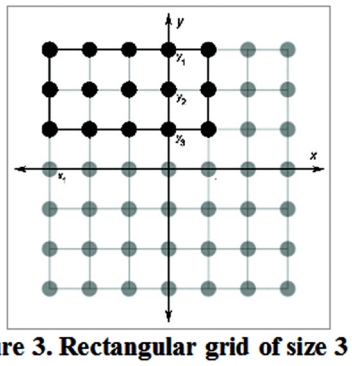

Figure 3. Rectangular grid of size 3 x 5

Figure 3 shows a rectangular grid of size 3 x 5

In our mathematical model, paylines are represented by particular lines in a rectangular grid (the display). The paylines of slot machines can be of any complexity for each slot machine in part, but usually they have particular shapes, following properties such as non-self crossing, colinearity, symmetry, up-down or left-right direction, and/or crossing over the reels.

With respect to probability calculus, there are only the length of a line, the number of particular lines in a given rectangular grid and the cardinality of their mutual intersections that count (for complex events involving several paylines), regardless of other properties of them.

For instance, the tables give the number of oblique lines included in an m x n-size rectangular grid and the number of trans-

Table of values for the number of oblique lines in a rectangular grid

n / *m*	2	3	4	5	6	7	8	9
2	0	0	0	0	0	0	0	0
3	0	2	4	6	8	10	12	14
4	0	4	10	16	22	28	34	40
5	0	6	16	28	40	52	64	76
6	0	8	22	40	60	80	100	120
7	0	10	28	52	80	110	140	170
8	0	12	34	64	100	140	182	224
9	0	14	40	76	120	170	224	280

Table of values for the number of transversal oblique lines in a rectangular grid

n / *m*	2	3	4	5	6	7	8	9
2	0	0	0	0	0	0	0	0
3	0	2	4	6	8	10	12	14
4	0	4	2	4	6	8	10	12
5	0	6	4	2	4	6	8	10
6	0	8	6	4	2	4	6	8
7	0	10	8	6	4	2	4	6
8	0	12	10	8	6	4	2	4
9	0	14	12	10	8	6	4	2

versal oblique lines.

In an n x n-size rectangular grid (a square grid), an oblique line of length n is called a diagonal. If , there are no diagonals in an m x n -size rectangular grid.

If m = n, there are exactly 2 diagonals. The diagonals in a square grid correspond to the common geometric diagonals of a square, passing through two opposite vertices. In the Euclidian plane, any rectangle has diagonals, but in a Cartesian grid, only a square grid has diagonals (in the sense of the above definition).

The following tables give the number of some particular triangular and trapezoidal lines included in an m x n-size rectangular grid, usually present at multiline slot machines.

Among these left-right transversal triangular lines, some of them may be symmetric (corresponding to isosceles triangles).

Table of values for the number of symmetric left-right transversal triangular lines in a rectangular grid

Table of values for the total number of left-right transversal trapezoidal lines in a rectangular grid.

Continues next month

Catalin Barboianu
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Table of values for the number of left-right transversal triangular lines in a rectangular grid

m \ *n*	2	3	4	5	6	7	8	9
2	0	2	0	0	0	0	0	0
3	0	4	4	2	0	0	0	0
4	0	6	8	8	4	2	0	0
5	0	8	12	14	12	8	4	2
6	0	10	16	20	20	18	12	8
7	0	12	20	26	28	28	24	18
8	0	14	24	32	36	38	36	32
9	0	16	28	38	44	48	48	46

Table of values for the number of symmetric left-right transversal triangular lines in a rectangular grid

m \ *n*	2	3	4	5	6	7	8	9
2	0	2	0	0	0	0	0	0
3	0	4	0	2	0	0	0	0
4	0	6	0	4	0	2	0	0
5	0	8	0	6	0	4	0	2
6	0	10	0	8	0	6	0	4
7	0	12	0	10	0	8	0	6
8	0	14	0	12	0	10	0	8
9	0	16	0	14	0	12	0	10

Table of values for the total number of left-right transversal trapezoidal lines in a rectangular grid

m \ *n*	2	3	4	5	6	7	8	9
2	0	0	2	2	2	2	2	2
3	0	0	4	4	6	6	6	6
4	0	0	6	6	10	10	12	12
5	0	0	8	8	14	14	18	18
6	0	0	10	10	18	18	24	24
7	0	0	12	12	22	22	30	30
8	0	0	14	14	26	26	36	36
9	0	0	16	16	30	30	42	42

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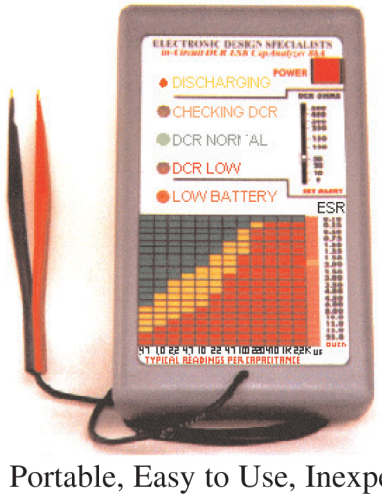

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About Randy Fromm: I am the publisher of Slot Tech Magazine. First published in 2001, Slot Tech Magazine is a monthly trade journal focusing on casino slot machine repair. I have been repairing electronics for the gaming industry since 1972. I really 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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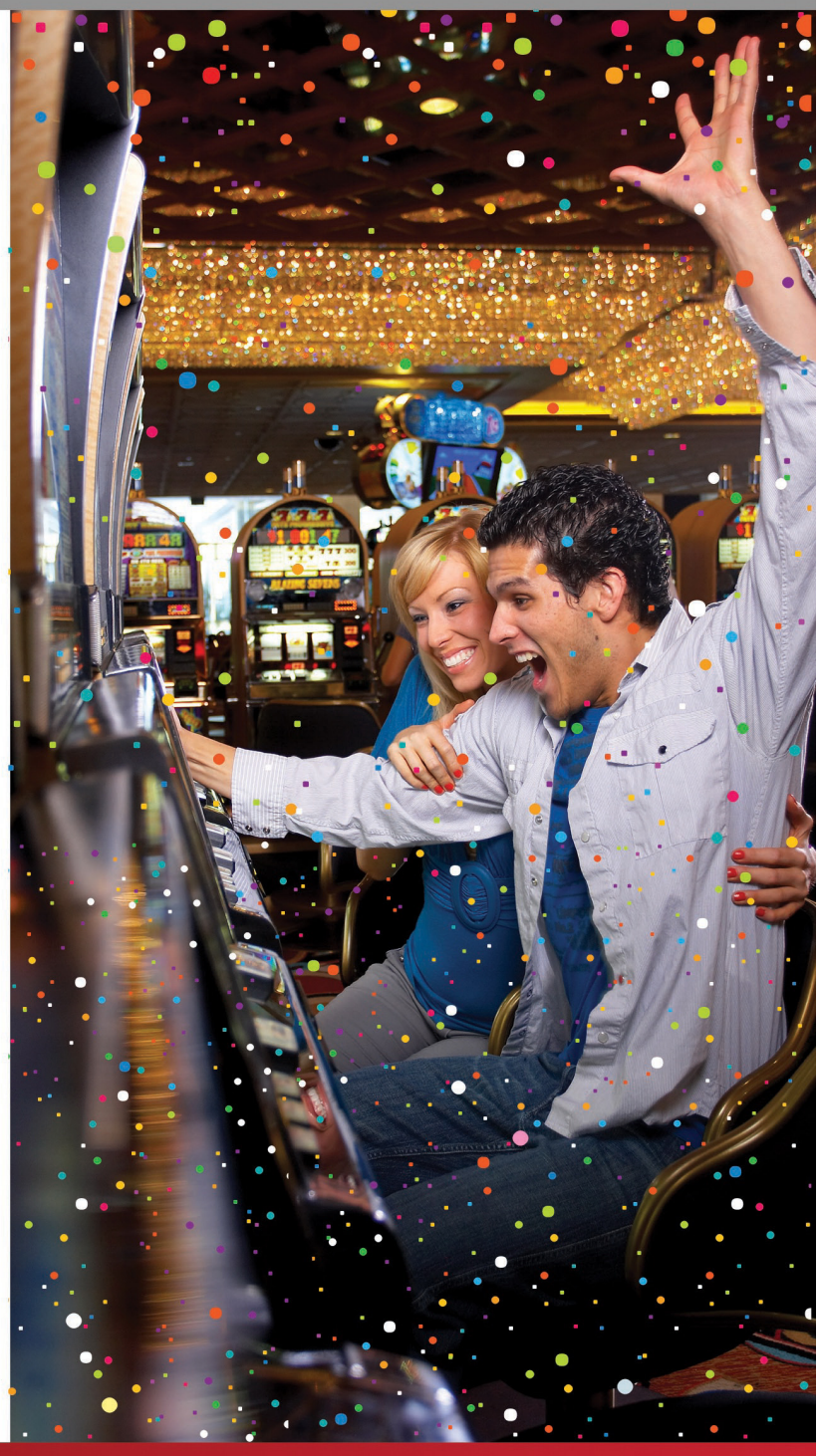

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