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Slot Tech Editorial

Please forgive me that this month's Slot Tech Magazine has come to you a bit later than usual. I just returned from this year's Global Gaming Expo and, as it occurs each year just at deadline, production was delayed in order to include some limited coverage of the show.

When I say "limited" I really mean it. There was a lot to see at G2E and I'm not even talking about all of the new game titles. Slot Tech Magazine doesn't really concern itself too much with that, anyway. I'll leave that up to other magazines (such as Casino Enterprise Management) who do a much better job at it than I do.

What I like to see at the show is things like new peripheral devices such as power supplies, monitors, bill validators, coin validators, ticket printers and yes, even the lowly push buttons and lamp assemblies. This is the stuff that interests me (okay, I'm a geek and I admit it).

But even limiting myself to just these things, it will take some time to get around to presenting it all to you. My point is that we'll get around to covering all of this stuff in the next few months. It's not going anywhere. In fact, some of the new products will not even be available for a few months anyway.

What you will find in this month's magazine is coverage of WMS' new "Bluebird" cabinet and their new CPU-NXT Operating System. You'll find coverage of FutureLogic's new GEN2 ticket printer and a look at tokenization from your friends at IDX.

Connector failure can plague slot machines with intermittent problems, especially when operating on board a cruise ship or at a seaside resort. In the first of a two part series, Slot Tech Magazine takes a look at connectors and all of the tools and pins needed to make proper repairs.

Herschel Peeler brings it home with his most excellent look at the WMS power supply.

For those of you who's booths I visited at G2E but who failed to appear in this issue, I ask you to be patient. For example, Ithaca has a really nifty, two-color thermal printer (black and red) that I just couldn't fit into this issue. CashCode has a REALLY interesting new product that deserves the space I just couldn't spare this month. Sorry, Marlon. I'll catch up with you.

Randy Fromm (l) with Ernie Stevens, Jr. (Oneida Nation of Wisconsin), Chairman of the National Indian Gaming Association (NIGA)

Randy Fromm

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THE BIG BOSS

Philosophical Ravings From the Great White North

By Kevin Noble

When observing experienced technicians in operation, you will soon observe one thing: There is no excitement. They're always calm, cool, and collected. Even though their hands move quickly from tools to equipment, there is little noise. The quiet is deceiving because the job is proceeding according to plan.

The "big boss" on every repair is your brain. It analyzes what has to be done and commands the hands to do it. The brain gets input from the task in hand through the senses, and instantly begins to review your "menu" to solve the problem, visualizing the steps and equipment needed.

In a short period of time you start to develop a technique; you start to sense instinctively the correct way to carry out the details of a job. Once the technique is learned and the technician has had practice, they begin to develop confidence. None of the techniques that are developed are really hard, they just need to be learned. The learning process is a continuing thing you can never be too good at. The technician uses common sense which provides information on whether the game is proper working order. Measuring and testing instruments will become an extension of our five senses. As a trained technician, you will work more easily with tools and testers to locate and solve the problems that you are faced with. A message flows from your brain to your hands, to the testers and equipment you start to develop thinking patterns. By isolating the problems you are faced with into different sub-systems of the slot machine, you can now narrow down the direction in which to take.

Thinking Patterns

The mind is a wonderful tool that can solve problems and plan procedures. Developing and feeding the mind with various bits of theory, information, and common sense, you will be able to apply your knowledge to real life situations out on the floor. The just learned theory and the technicians thinking patterns will take over as you work. As time goes by, you will refine you special skills more and more until your troubleshooting and decision making skills becomes natural, thus reducing troubleshooting time.

Developing Your Mind

The development of your mind will involve the common practices of many subjects associated with the slot machine. Over time you will be introduced to several of these systems such as the following:

AC/DC power supply
Coin in
Coin out
Game outcome display
Security
Player input
Game accounting
Diagnostic

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rescent lights, monitors, and most hoppers. Fuses and inline filters also make up part the AC system. The DC supplies voltages to operate the computer systems, sound systems, graphics systems, reels and some hoppers.

Coin-In

The coin-in system consists of the coin comparators, optical sensors, and diverters. This allows for the acceptance of valid coins and the rejection of slugs, invalid coins, and prevents stringing. The diverter is used to divert the extra coins into the drop.

Coin-Out

The coin-out system consists of the hopper. The responsibility of this system is to pay out the correct amount of coins to the customer, at the same time detecting any extra coins paid out, and jams.

Game Outcome Display

The game outcome display involves reels and monitors. The responsibility of this system monitors the correct motion and stopping of the reels, and in the monitors allows for the display of the outcome of game play, also including indicators, attract modes, and error messages.

Security

The security system consists of monitoring of the door, coin optics for stringing, and correct reel positions. Error codes and tower lights help alert the technician of possible problems and, at the same time, steer the technician where the problem might lie.

Player Input

The player-input system consists of switches and handles. These are inputs that can be controlled from the patron such as cashing out, spinning, or calling for a slot attendant.

Player Update (Display)

The player update system consists of lights, sounds and displays. Illuminated lights provide the customer the status of the game. Sounds provides stages of different game plays, wins, or jackpots, and the displays shows how many coins are bet, won, credits amassed, and error codes for the technicians.

Accounting

The accounting systems consist of two different sets of accounting information. The hard meters, and the soft meters. The hard meters are the less reliable electro-mechanical meters, and the random access memory's soft meters that are stored in the CPU board.

Diagnostic

The diagnostic system gives the technician the ability to select and activate inputs and outputs and verify that they function properly. Some often used tests available to the technician are hopper testing, coin lock out, pay table verification, lights, and switch operation.

Notes, Forums, and Contacts

This most important information that I have come across is my contacts. Just a phone call or e-mail away I could have the answer to my questions in minutes or hours. Experienced Technicians such as Herschel Peeler, Robert E. Sult, Nancy Gammon, and Ed Whitman, (some who I never had the pleasure to meet) to Joe Sayor (IDX), Mark Robinson (Bally Gaming), Larry Jones (Konami Gaming), and Jack Riley (Royal Flush Gaming) just to name a few (sorry guys I cannot name them all). The Delphi Technical forum is important because there are so many technicians that have dealt with and experienced other manufactures games and systems.

Lastly, I have all the notes that I have gathered and stored from all my experiences and from other technicians willing to pass on their knowledge. I am fortunate to have access to all the manufacturer's manuals in the shop to read up on, their technical representatives, and no restrictions to contact these individuals to repair, solve or inquire about any information. My logbook where I have logged all the difficult problems I have come across to look back on when my memory has just plain forgot.

Words of Wisdom

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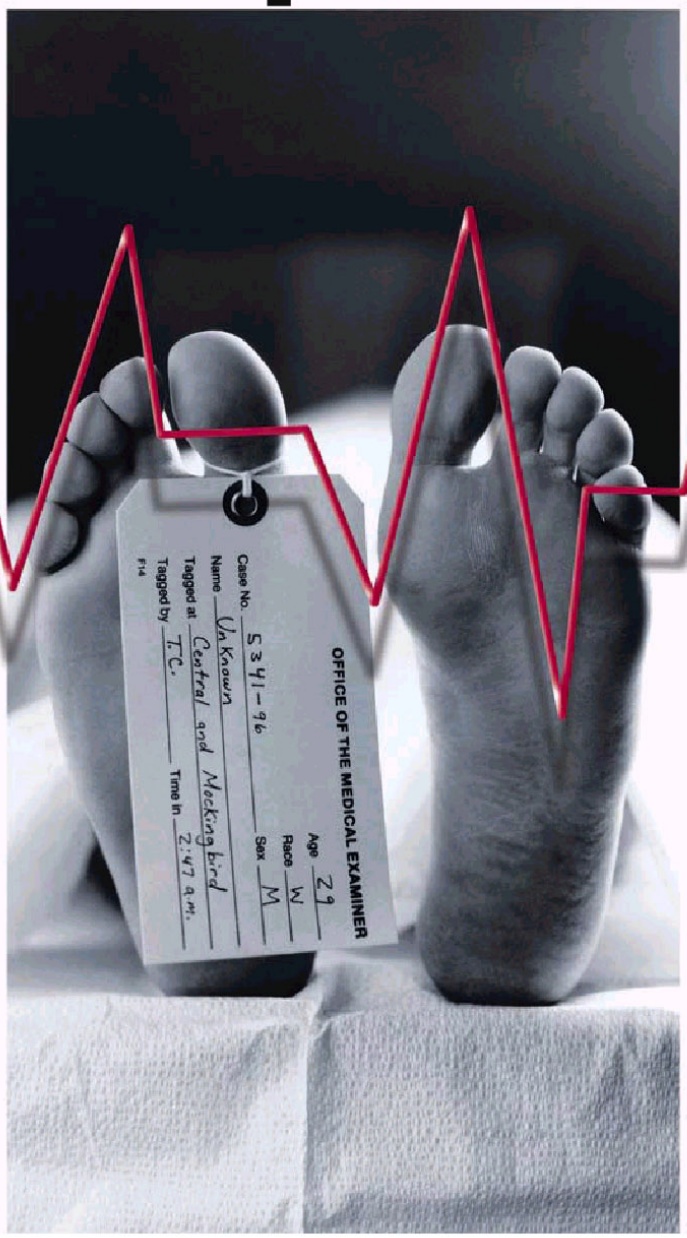

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The most important "words of wisdom" that I believe in, are "always cover your ass." What I mean by this is always checking that the slot door is closed, that your keys and cards are on you at all times when leaving a game, and that you document all your findings or abnormalities in the m.e.a.l. book in case something happens. I have found out that certain people get a natural high when discovering that somebody has made a mistake. They remind me of vultures circling high above me, just waiting to swoop down and start gnawing at my corpse.

Last but not least, when in doubt "ask questions." I have always tried to answer any questions to the best of my knowledge. If I did not have the answer, I would tell them that I didn't know, but that I would find out for them. The new technician just starting out will believe almost everything you tell them, and giving advice just for the sake of looking good will actually hurt them. This is where you start to develop a trusting working relationship.

Overview

Our goal, as far as being a technician goes, is to really be able to understand the theory, operation and the separation of the different systems in the slot machine. The knowledge learned and the skills that are developed are our firepower on the job. We perform important tasks day after day with newfound information. You should realize that your accumulation of mental tools has just begun. You've only touched the surface in learning about several areas of slot machines systems. Learning will get more and more exciting as your knowledge of various systems increase. Remember, the hands themselves can't turn a screw, cut a wire, or solve a problem, but it's the brain that helps do the job. So dust it off and take it for a spin. Once your technique is learned and practiced, the beginner becomes the expert.

- Kevin Noble
knoble@slot-techs.com

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Meet Kevin Noble's New Baby

Meet Alyssa June Noble, Born August 11th, 2003. That's her older sister, Jaclyn looking somewhat bewildered by the new arrival. Congratulations to you, Kevin and the lovely Mrs. Noble. - rf

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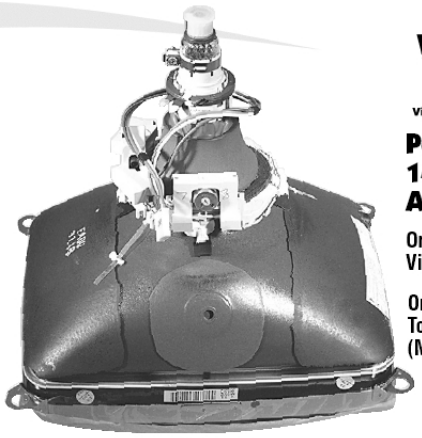

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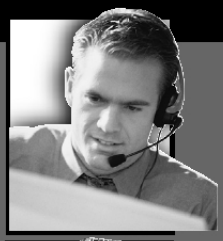

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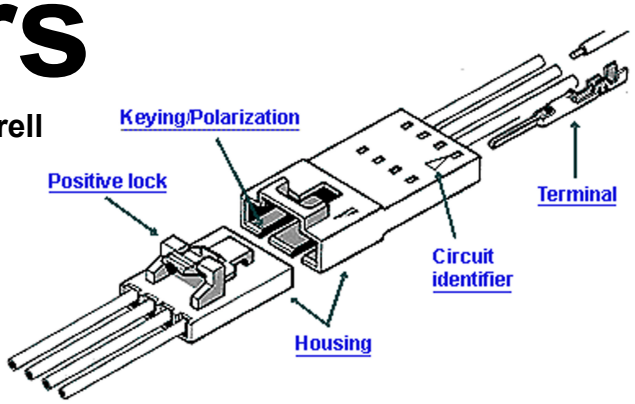
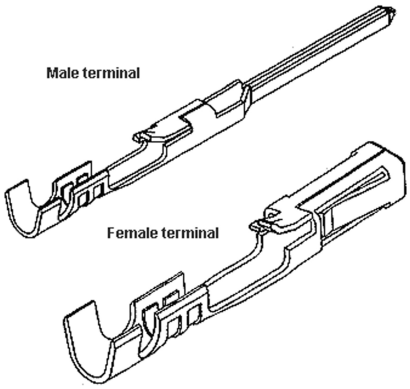
Connectors

By Clay Harrell



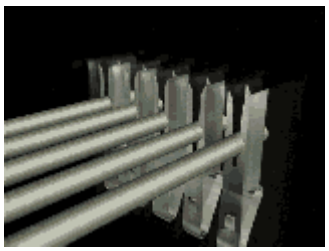
Why Use Connectors? You don't need a connector to complete a circuit. You could solder components together. However, imagine the effect soldering would have on assembly manufacturer, repair and upgrades. Using connectors offers several important



advantages over permanent connections:

Connectors improve manufacturing - Connectors make it easier to assemble electronic products. They also facilitate mass production processes.

Connectors ease repairs - If an electronic component fails, connectors allow a technician to quickly replace it with a new one.



Connectors permit upgrades - As technology advances, connectors allow us to replace old components with newer, more sophisticated ones.

Connectors allow design flexibility - Connectors give engineers the flexibility to design and integrate new products and components into existing systems.

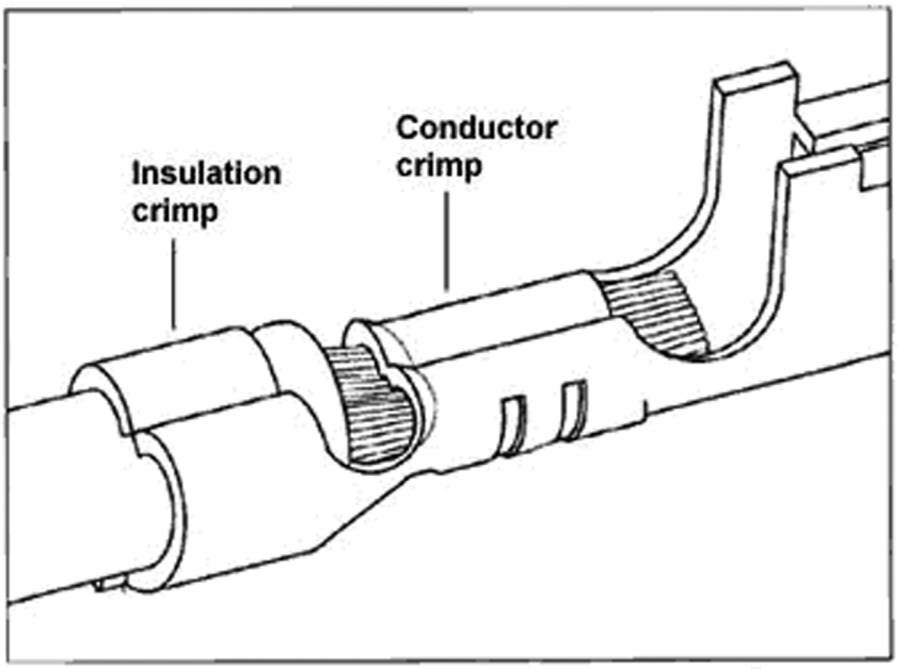
Housing

Usually made of molded plastic, a housing is a connector's casing. Its main functions are to hold the terminals and protect them from shorting, dust, dirt, moisture, and electrical interference.

Terminal Pins. Terminals are the metal components in a connector that conduct current. They are also known as contacts, and they are usually either male or female, as shown on the right. You may hear certain types of male terminals referred to as leads or posts. Terminals are inserted into connector housings. When the connectors mate, the terminals meet and bridge the circuit path.

Methods of Termination

Termination is a key concept in connector design. It refers



to the method used to join a terminal and a conductor. Good termination assures sound electrical contact and maximum strength between the conductor and the terminal (for a gas-tight connection, to prohibit corrosion). The most common termination methods are listed below and discussed on the next few pages.

- Crimping: What all replacement slot machine connectors should use. Also utilized by many others, especially the auto industry.
- Insulation displacement: What OEMs (Original Equipment Manufacturers) use.
- Surface mount: hi-tech electronics industry.
- Wire wrap: for prototyping.
- Soldering.
- Press fit.

Termination-Crimping

In crimping, a metal sleeve is secured to a conductor by mechanically crimping the sleeve with pliers, presses, or automated crimping machines. Note that the conductor is crimped in two places - on the wire and on its insulator. The latter is called a strain relief. It provides additional resistance to mechanical stress. A "good crimp" provides a gas-tight connection on the terminal pin, which prohibits corrosion at the wire to terminal pin connection. Since a crimped connection can easily be performed with an inexpensive hand crimper, and provides an excellent gas-tight connection, this is what should be used on most replacement

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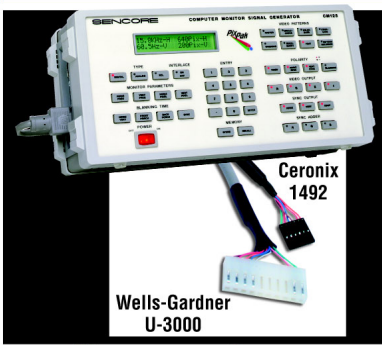

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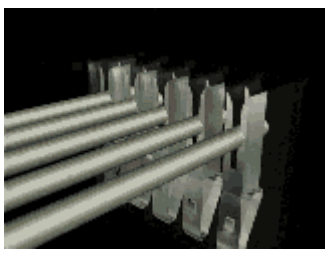
slot machine applications.

Crimped connectors also work well in a production environment. Molex makes automatic crimping tools and dies which can feed terminal pins and wires, doing many crimps automatically per minute. After talking to the Molex tech advisors, they admitted this: "Hand crimpers are a necessary evil. We don't like them, and wish we didn't have to sell them. They can provide inconsistent crimps, with the possibility of human error. And they can make our highly engineered products fail when they should not fail, if machine installed." So keep that in mind when hand crimping! The end result is all up to you. We'll look at hand crimping later on.

Termination-Insulation Displacement.

In insulation displacement technology (IDT), an insulated wire is pressed into a terminal slot smaller than the conductor diameter, displacing the insulation to make electrical contact. In application, insulation need not be removed, which is a major advantage of this method of termination using Insulation Displacement Connectors (IDC). As a replacement, this style connector should be avoided.



IDT connectors are great for manufacturers. There's no separate step of stripping the wire for connection to the terminal pin, and no crimping step. Basically the only connection step involved is mating the wire to the IDT connector and pressing it in place. In the short time, an IDT connector works fine. But over time, due to the design of IDCs, the "V" that cuts through the wire insulation can also eventually cut the wire strands too (causing a decrease in current handling, which can mean a burned connector). Also, the wires can be pulled/ripped from the IDC terminal pin much easier than a crimped connection. And lastly, the tool required to do a good non-production IDT connection is expensive, compared to a hand crimper (I'm not talking about that small IDC mushroomed shaped tool).

Pitch

Pitch is the distance from center-to-center between adjacent conductors. Pitch also affects arcing, which can cause interference between adjacent conductors in a connector. The most common pitch size used in slot machines is .100" (for low voltage data) and .156" (for power connections).

Connector Levels

There are many types of connectors. However, each type fits into one (or more) of five categories. In the industry, these categories are known as levels. The levels were defined by major connector companies under the auspices of an organization called NEDA.

* Wire-to-Board or Subassembly-to-Subassembly Level.
* Box-to-Box or Input/Output Level
* IC Chip or Chip-to-Package Level.
* IC Package or Package-to-Board Level.
* PC Board-to-Board Level.

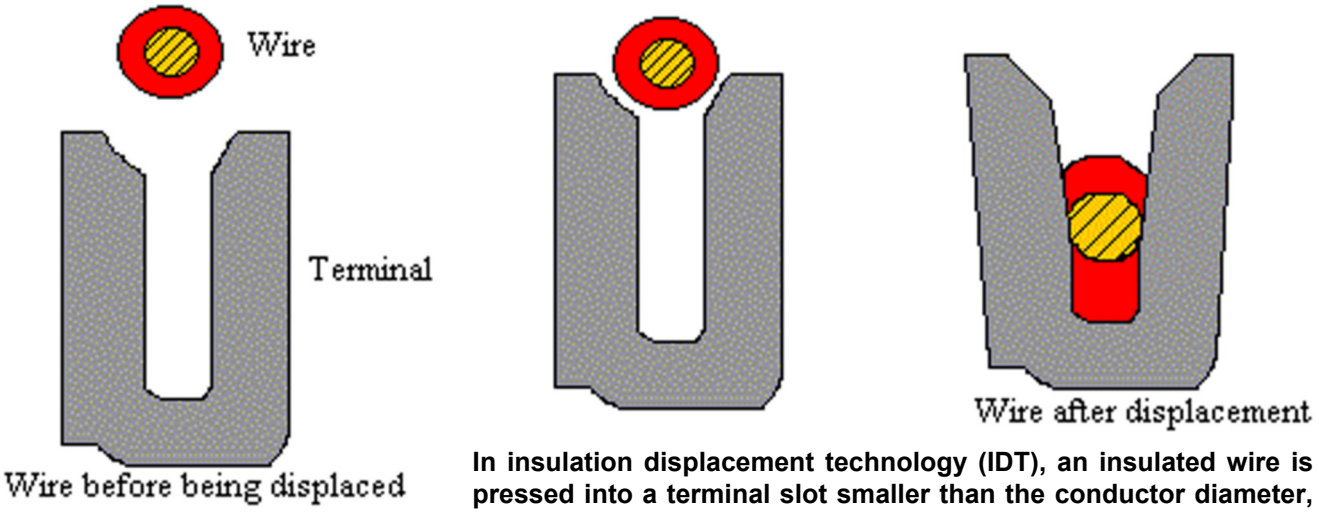
Signal and Power Connectors

There are two broad types of connectors: signal and power. They are often distinguished by the amount of power they carry. But the key distinction is that signal connectors have minimal resistance to current flow. This minimizes disruption of the relatively weak signals flowing through them.

Conductors and Insulators

Electrical charge moves through some materials better than others. Substances through which electrons flow freely are called conductors. Substances that resist the flow of electrons are called insulators. In the electronics industry, a more common term for insulator is dielectric.

Copper wire is an excellent conductor because it has a large number of free electrons. If a copper wire is connected between the terminals of a battery, free electrons in the wire move from the negative terminal to the positive terminal. This free flow of electrons is electric current.



In insulation displacement technology (IDT), an insulated wire is pressed into a terminal slot smaller than the conductor diameter, displacing the insulation to make electrical contact.

Terminals as Conductors

In a connector, current is conducted through the connector by the contacts or terminals, which are made from various metals. Metal is one of nature's best conductors because it has a lot of free electrons. When two metal terminals mate, electrons can flow from one surface to the other, continuing the circuit.

Insulators in Connectors

Plastics are used in connector housings because of their excellent dielectric properties. Like all good insulators, plastic resists the flow of electric current. The electrons of an insulator are tightly bound to their atoms and cannot move freely, even if you apply an external charge. Other common insulators are glass and rubber.

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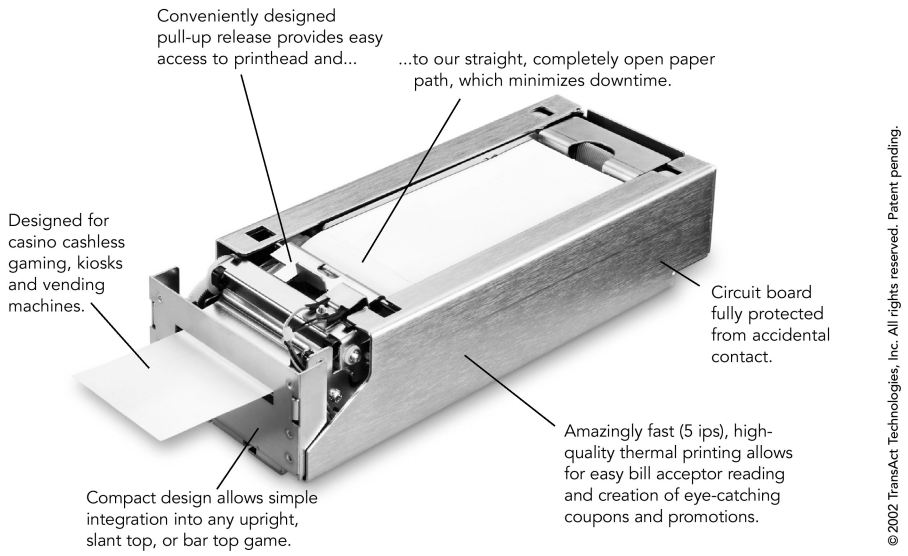

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Voltage

Voltage is a force that pushes electric current through a circuit. It causes electrons to jump from one atom to another. Voltage is often referred to as electric pressure, and is indicated by the V symbol. Typical connector voltages are 50V, 125V, 250V, and 600V.

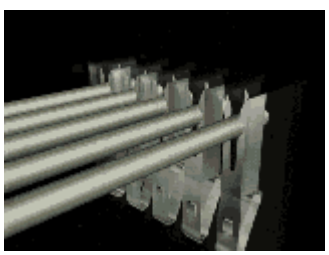
Current Rating and Amperage

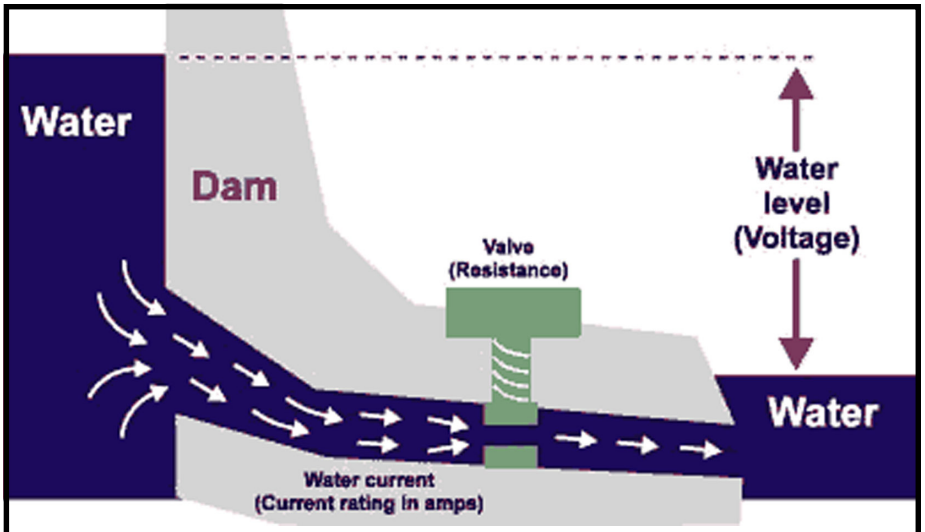
Current rating indicates the rate of flow of electricity. It is measured in amperes and is indicated by the letter A. In a connector specification, this figure indicates the maximum amperes at which the connector can be used continuously without electrical or mechanical failure.

Amperage is similar to gallons per minute or gallons per second. It indicates how much electric current flows past a certain point in a given time period. Connector current ratings are usually in the range of 1A to 50A per circuit.

Resistance and Ohms

Resistance is a material's tendency to inhibit electron flow. Resistance is measured in ohms. This specification indicates the maximum resistance of the contact area when the connector is mated. Typically, this is less than 25 milliohms.





This dammed river image is often used to explain electrical measurements. Voltage is like water pressure. No force actually pushes electrons through a circuit. Rather, like the water level, the difference between the two levels forces the flow. The greater the difference between levels, the greater the flow.

In the water example, resistance is caused by the valve. Tighten the valve and the rate of flow decreases. In a conductor, resistance is a property of the material. It occurs when electrons collide with atoms and give up energy. A conductor like copper has low resistance.

The Relationship between Voltage, Resistance, and Current

It's important to understand that voltage, resistance, and current are not independent of each other. They have an intimate relationship. Their relationship is expressed by Ohm's Law. When selecting a connector, all three must be considered and matched to the application.

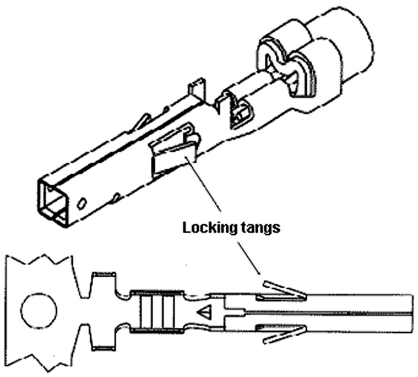
Ohm's Law

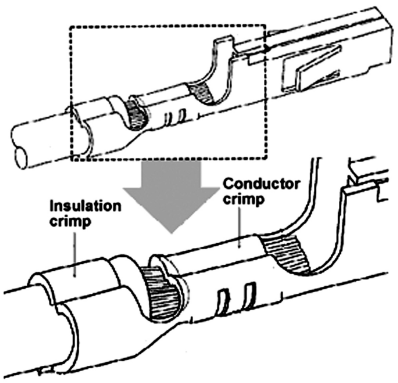
The current in an electrical circuit is directly proportional to the voltage and inversely proportional to the resistance. Voltage = Current x Resistance, or Current = Voltage/ Resistance.

The important point about Ohm's Law is that, when selecting connectors, all the electrical specifications must be considered. All metals have inherent resistance. The greater the resistance, the more voltage is required to push the current through the connector. Using Ohm's Law we can determine the overall efficiency of a connector.

Mechanical Specifications of Connectors

The mechanical specifications of a connector indicate how a connector performs under critical mechanical actions. These are of great importance to customers who must match





the right connector to an application.

Contact Insertion Force

This specification identifies the mechanical force required to insert a terminal into a connector housing.

Contact Retention to Housing

Contact retention force holds a terminal in a housing cavity. This prevents terminal backout, or the coming loose of the terminal. Typically, locking devices called tangs secure the terminal against the housing walls using spring-like pressure. The contact retention to housing specification describes the force required to remove a properly seated terminal.

Wire Pull-Out Force. This specification describes the force required to separate a wire from a terminal by pulling them apart. This is primarily a function of the termination method and the quality of the termination. In a crimped terminal, for example, both the insulation and conductor are crimped to assure maximum wire pull-out force.

Mating and Unmating Force

This specification describes the force required to join and separate two halves of a connector. This is the sum of contact mating forces plus any additional force necessary to overcome minor misalignment of connector halves and any dimensional variations in the housings.

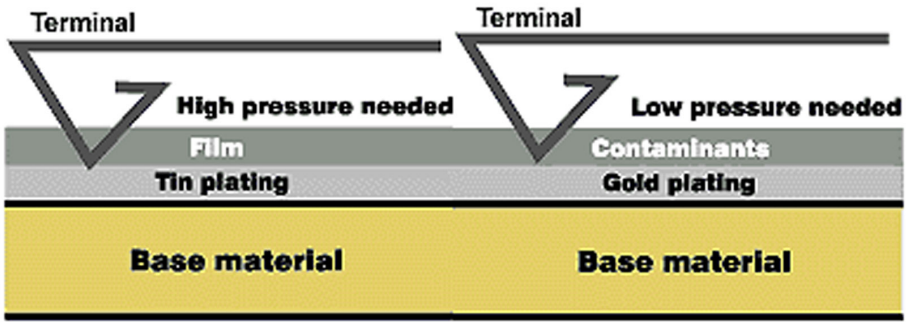
Normal Force

Once terminals are mated, normal force is the pressure applied perpendicular to the terminal interface. This pressure assures a gas tight condition between the terminal surfaces. This is considered the most important mechanical specification because it assures a consistent and high quality electrical contact.

Durability of Terminal Pins and Header Pins

Durability indicates the number of times a terminal can be mated and unmated without degrading performance. Durability is measured in "cycles" (the number of times a connector can be removed or installed). As shown above, durability varies with the materials used.

The typical connector (tin plated) has a life of 25 cycles.



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That's pretty low! But after 25 insertions or removals, the terminal pin's plating and retention (ability to retain shape) are compromised, and reliability will suffer. Header pins also have the same problem with plating (but not retention!) Add vibration into the formula, and the cycle life is probably even lower. Connectors are sometimes a problem in slot machines (of any slot machine manufacturer).

Common Metals Used in Molex Terminals

Metal	Characteristic	Usage
Brass	Zinc content varies from 5-40% Cheapest metal by weight Molex standard metal is 70/30 copper/zinc Good spring, strength and electrical properties	KK Terminals
Phosphor Bronze	Good strength, toughness, conductibility Excellent fatigue resistance Superior elasticity	Electrical contact springs
Beryllium Copper	Finest copper alloy for spring terminals Increasingly used by Molex Price significantly better than phosphor bronze	Applications demanding optimum performance
High Copper Alloy	High strength modified copper Good thermal and electrical properties Resists softening at high temperatures	Mainly automotive applications

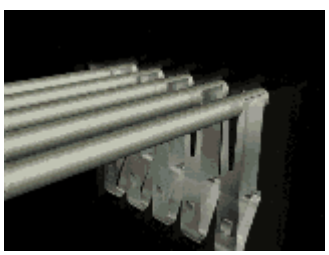
Stamping Materials

Terminals and pins are made of a variety of metals, each with different properties. Because of their atomic structure, metals are excellent conductors of electricity. Metals also have mechanical properties that make them ideal for connector terminals.

The properties of metals that are of interest to connector manufacturer are:
* Electrical conductivity
* Mechanical strength
* Formability
* Resilience (ability to return to its original shape after slight deformation)

Plating

Metals that have good mechanical properties do not always have ideal electrical properties. Plating is the process of coating terminals of base metal with a layer of nickel, tin, or gold to improve their electrical performance.



Common stamping metals include brass, phosphor bronze, beryllium copper, and other copper-based alloys. As you have learned, these metals have good strength, spring, and formability. Yet each of these metals has electrical deficiencies. To overcome these deficiencies, terminals made from them are plated with gold, tin and tin-based alloys, and palladium/nickel alloys.

Copper-based alloys have ideal mechanical properties, but they do not meet other connector design requirements. They are plated to improve:
* Electrical performance
* Solderability
* Corrosion protection

Slot machine connector pins can be made of brass but phosphor bronze is a better choice for power circuits as it has higher current rating. Beryllium copper is also good, but often not available for the terminal pins needed.

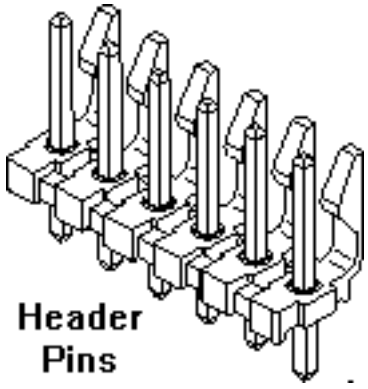
For example, for .156" trifurcon terminal pins series 6838, here is a comparison of brass versus phospher bronze current (amp) ratings:

Trifurcon Terminal Pins

The Trifurcon design provides three distinct points of contact from the terminal pin

Wire Guage	18	20	22	24	26
Phospher Bronze	7.00A	6.25A	5.50A	5.00A	4.50A
Brass	5.00A	4.75A	4.50A	4.25A	4.00A

(above left) to the header pin (above right). This is the ideal choice where high shock or vibration exists. For low current/voltage, Gold is recommended (contact factory). Phosphor Bronze recommended for higher rated current circuits. Trifurcon only available for .156" and larger pitch.



Common Plating Metals

Metal	Characteristic
Tin	Overall, excellent terminal finish Most widely used plating material Low cost Excellent conductivity Excellent solderability Low durability and corrosion resistance
Gold	Excellent corrosion resistance Excellent solderability High cost Soft, but cobalt or nickel are added to harden Selective plating reduces cost
Palladium/ nickel alloy	Less expensive alternative to gold Considered the best substitute for gold Excellent solderability Improves cycle life

Plating and Corrosion

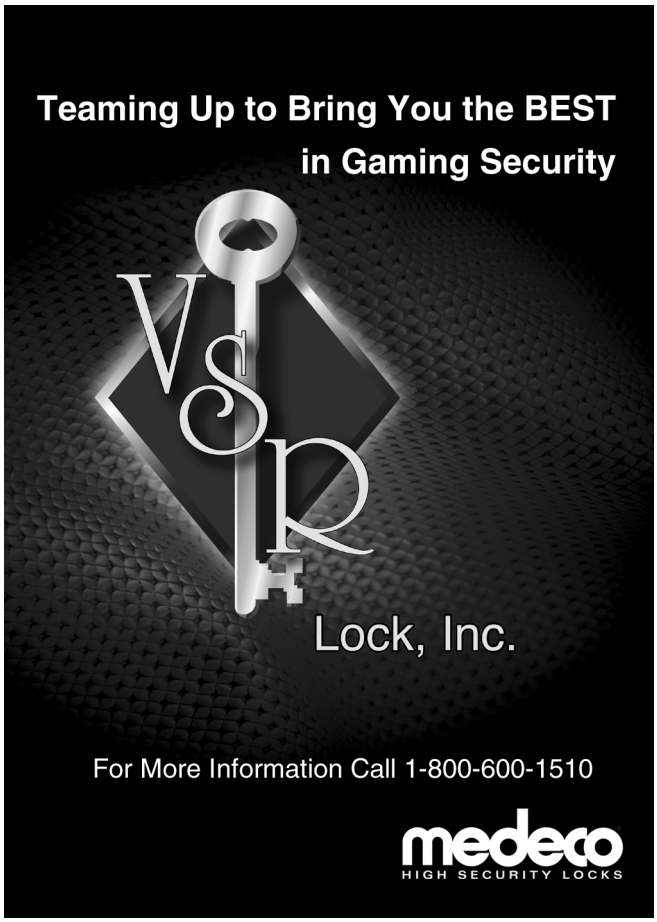
Recall that corrosion is the deterioration of a metal due to exposure to moisture or other contaminants. This is a key concern of connector designers. If voltage or wiping pressure is high, a corrosive layer is easily penetrated. But in low voltage situations, even slight corrosion can obstruct current flow. Plating materials such as gold are chosen for their high resistance to corrosion.

Metals vary in their resistance to corrosion. The relative corrosion resistance of different metals varies, from aluminum, which corrodes easily, to gold, which does not corrode at all. The list below shows from top to bottom, metals which corrode easily (1) to metals that do not corrode at all (10):

1. Aluminum
2. Zinc
3. Iron
4. Cadmium
5. Nickel
6. Tin
7. Copper
8. Silver
9. Palladium
10. Gold

Tin versus Gold Plating

Terminals plated with tin or tin alloys oxidize and are contaminated by gasses, water vapor, and organic molecules. This film degrades conductivity, so sufficient wiping pressure must be applied to break the film. This pressure also removes tin plating, which decreases durability. Gold Plating Oxide film does not form on gold, so wiping pressure can be lighter to penetrate only the contaminants. Durability is much higher, often in the hundreds of cycles. This is why modular phone jack terminals, which may be mated and unmated many times, are usually gold plated.



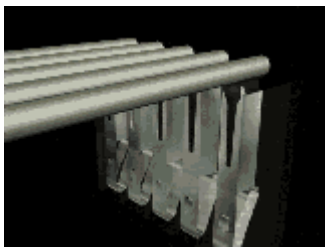
Selective Gold Plating

The process used to plate gold only in selected areas of a terminal. Selective plating assures that critical terminal areas are plated, but non-critical areas are not. This reduces costs.

Do NOT Mix Gold and Tin Terminals and Headers! It is not a good idea to mate a gold terminal to a tin header (or vice versa), or mix any other dissimilar connector metals. Use the same metal for both contacts! The contact resistance will go up with dissimilar metals, causing all sorts of problems (depending if it is a logic connector or power connector). This exact problem has been seen in the automotive industry. Though no cars have been recalled because of this (that I know of), there have been numerous "engineering actions" and "service bulletins" because connectors have mixed gold and tin parts.

When are Connectors Worn Out?

Failing connectors can cause a great number of problems in slot machines. For example, random game resets (where the game seemingly turns itself off and back on during a game), game lockups, switches and lamps that don't work, and other random and unpredictable behavior are often attributed to failing connectors.



Re-Seating Connectors - The False Hope

A good many slot techs will try and "fix" these problems by doing a connector "re-seat." That is, they will remove and reinstall the questionable connector in an attempt to "fix" the problem. Unfortunately, this does *not* fix the problem! Connector re-seating is a great way to identify a connector problem. If the problem goes away with a "re-seat" that means the connector needs to be replaced. But the re-seat itself does not fix the problem. The only way to fix the problem reliably is to replace all the connector parts involved.

The Life Span

The style of Molex connectors used in slot machines generally have a 25 "cycle" life span (a "cycle" is one removal and re-installation of a connector). And frankly, after as few as five cycles, there could be problems.

Re-Seating Five Times to "Clean"

The other false "repair tip" heard among many repair people is to "reseat a connector five times to 'clean' it." This is not only a bad idea, but it just makes things worse (because it eats up five cycles in the connector's already short 25 cyle life span). Again the reseat principle is great at IDENTIFYING a connector problem, but it does NOT fix anything!

The exception to the reseat rule involves gold plated connectors. These have a much lower terminal pin tension, and a higher 100 cycle life. In the case of gold connectors, the "re-seat to clean/fix" is acceptable. But if the connector in question is a .156" or .100" Molex connector, I don't care how old/new the game is, if re-seating "fixes" the problem, that connector needs to be replaced! No ifs, ands, or buts.

Gas Tight Seal

For a connector or socket to be reliable, it *must* have a "gas tight" seal (air tight, but the connector industry calls it "gas tight"). In the situation of the slot machine, nearly all connectors/sockets are tin on tin. To keep tin on tin gas tight, a fair amount of terminal pin tension is required against the male pin. The amount of tension needed has to do with the corrosion properties and wear properties of tin.

If the gas tight seal is compromised on a tin on tin connector/socket, corrosion works on the junction, and an intermittent connection is the result. This corrosion is usually the result of either:

Decreased pin pressure (too many cycles and/or too much vibration). Worn parts (the tin plating is worn from too many cycles and/or too much vibration, and does not pro-

tect against corrosion like it once did).

Reseating does NOT fix the lack of a gas tight seal on tin on tin connectors or sockets! If corrosion has started, re-seating does not fix this. All it does is temporarily "fix" it, until corrosion comes back (and it WILL come back!). A connector/socket that works after re-seating is telling the repair person something ("re-place me!") My suggestion is to listen to the game.

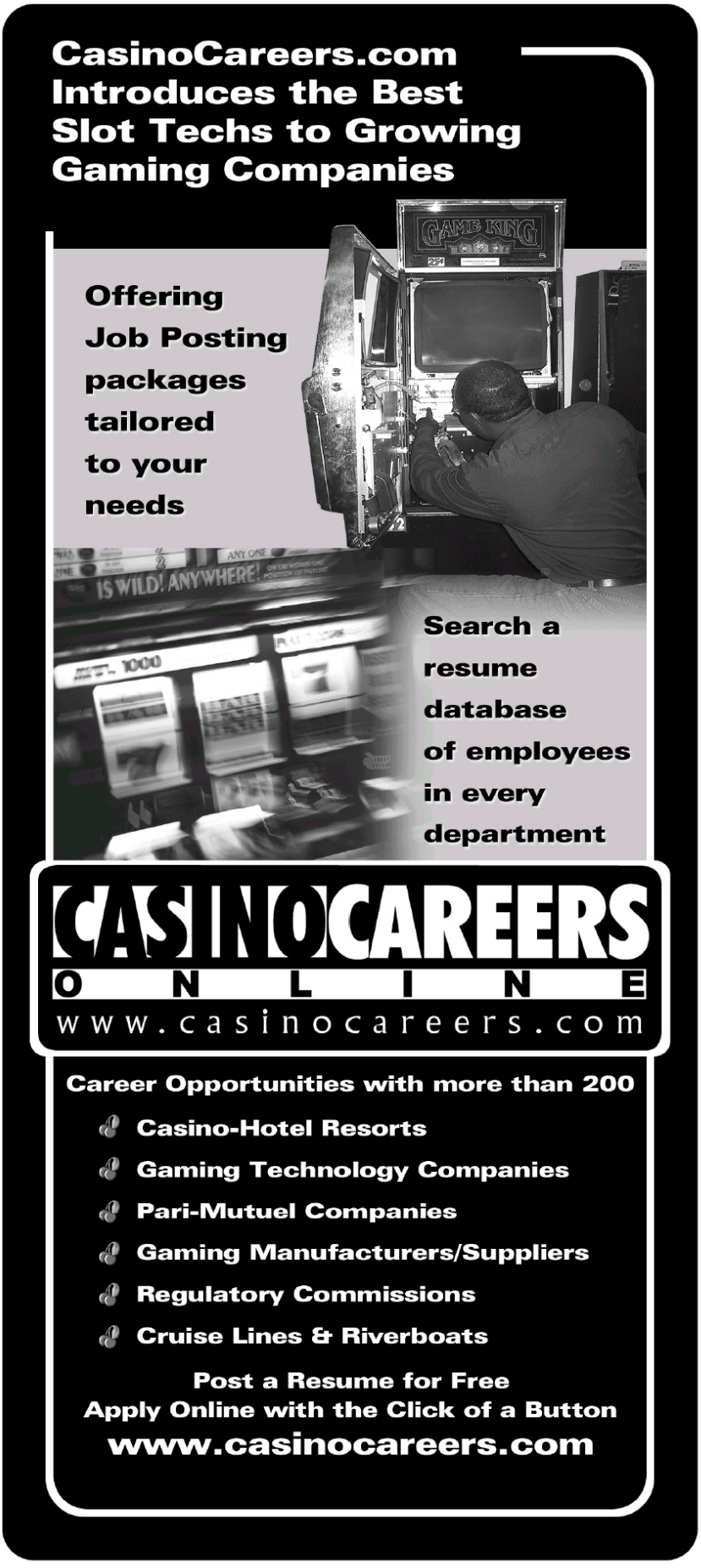
Connector Tools & Parts Needed, and Where to Get Them

There are certain tools and parts should be in every slot tech's toolbox to make the job better and easier (no, needlenose pliers can *not* be used to crimp connectors!) There's no cheap way to do this. The right tools and parts are needed, so just honker down and buy them.

Tools Needed

Here are the minimum con-nector tools required.

Terminal Pin Hand crimper. These are used for all the different styles of Molex ter-minal pins. Molex crimper #63811-1000 (inexpensive but versatile, type 6), or Molex crimper #11-01-0015 (excel-lent but more expensive, type 3), or Waldom/Molex crimper WHT-1921 (good yet inexpen-sive, for .100"/.062" and .156"/.093" pins), or Waldom/Molex crimper WHT-1919 (really for .156"/ .093" pins only), or Amp 725



(probably no longer available), or even Radio Shack #64-410 (last resort, not very good and not recommended).

.093" Round Pin Extractor Molex part number 11-03-0006, or Waldom/Molex part number WHT-2038, or Radio Shacks part number 274-223 (in this case the Radio Shack tool is pretty good).

.062" Round Pin Extractor Molex part number 11-03-0002, or Waldom/Molex #WHT-2285. Optional, as this size is not used nearly as much as the .093" size.

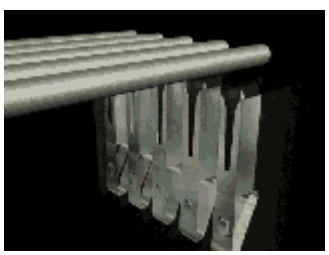
.156" terminal pin extraction tool from card edge connector housings Made of spring steel, Molex part number 11-03-0016 (rubber handle version), or Molex #11-03-0003 (bare bones version).

Picture by aeroelectric.com

The BCT-1 hand crimper's different jaw sizes for different size connector pins. The "C", "D", and "E" pockets are used to crimp the bare wire to the Molex connector pin. These pockets cause the end of the pin's wire grip wings to curl over and dive into the center of the wire strands. Pockets "A" and "B" have a smooth circular shape, and can be used to crimp the terminal pin's insulation-grips into a "bear hug" around the wire's insulation, but Molex suggests using the C,D,E pockets for insulation too.

Parts to Keep On-Hand for Slot machine Applications

The following are standard Molex connector parts commonly used in slot machines. Note there are some game specific Molex connectors that are not listed here, because they are specific to only those games. All the below terminal pins and housings are the crimp-on variety. If the game being repaired uses IDC connectors, to utilize the more robust crimp-on connectors, the plastic housing will probably need to be replaced in addition to the housing terminal pins and male circuit board header pins.



* .156" header male pins Molex #26-48-1155 (15 pin, with lock, cut to size).
* .156" plastic housings Molex #09-50-3151 (15 pins, cut to size).
* .156" plastic housing polarizing pins Molex #15-04-0220.
* .156" Trifurcon connector terminal pins Molex #08-52-0113 (the replacement pin of choice, used extensively in slot machine; buy lots of these).
* .156" connector terminal pins Molex #08-52-0072 (non-Trifurcon, used far less often and not as good as Trifurcon, but still needed in some situations).
* .100" header male pins Molex # 22-23-2121 (12 pins, with lock, cut to size).
* .100" plastic housings Molex # 22-01-3127 (12 pins, cut to size).
* .100" plastic housing polarized pin Molex # 15-04-9210.
* .100" terminal pins Molex # 08-50-0114.
* .093" round female terminal pins Molex #02-09-1119.
* .093" round male terminal pins Molex #02-09-2118.

Where to Buy This Stuff

All the above Molex connector parts are available from parts houses like Happ Controls, AG&E, Wholesale Electronics, MCM Electronics and

Left: Molex/Waldom .093" pin extractor #WHT-2038.

Middle: Radio Shack .093" pin extractor #274-223.

Right: Molex spring steel card edge extractor #11-03-0003.

Mouser Electreonics. To get the Mouser part number (which can be viewed/ordered on Mouser's web page), just add a "538-" before the Molex part number listed above (for example, "538-08-52-0113" is the Mouser part number for Trifurcon Molex terminal pins, as "538" is Mouser's manufacturer number for Molex).

Pt. 2 next month

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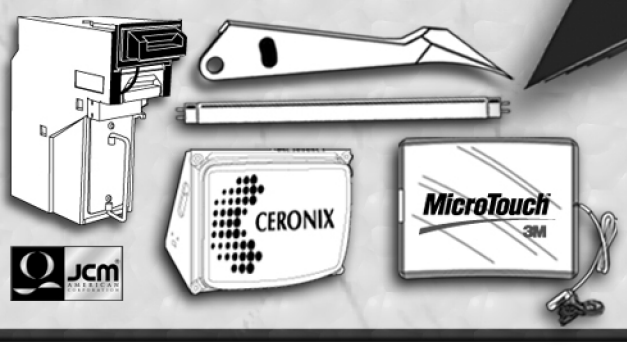

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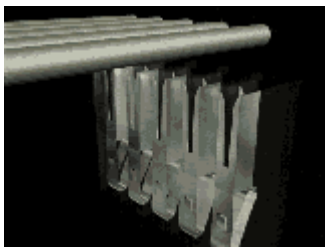
WMS Gaming Debuts New Gaming Platform at G2E

WMS Gaming Inc., debuted its new hardware platform, operating system and over 40 original games at the third annual Global Gaming in Las Vegas, September 16-18. For the first time ever, WMS displayed games for sale which address all of the product lines typically featured on a casino's slot floor, including mechanical reel games, multiline video games, poker games, and new participation games. In addition, WMS unveiled its proprietary, new wide area progressive system featuring the first jackpot link for this product line, MONOPOLY Money.

The centerpiece of WMS' G2E booth was the debut of the commercial version of the Company's CPU-NXT operating system and hardware, which recently received its first regulatory approval, and its award-winning Bluebird gaming cabinet. The CPU-NXT operating system and Bluebird gaming cabinet are at the core of WMS' re-launch as a full service provider of a complete line of gaming products.



"Over the last twenty-one months, WMS has dedicated itself to developing a full line of value-added products and a library of creative games," said Brian R. Gamache, President and CEO of WMS Industries. "The result of these collective efforts will be premiered at G2E. We are delighted to debut the marketable versions of our new CPU-NXT operating system and Bluebird gaming cabinet. Our engineers and designers have implemented improvements on these products over the advance preview versions that we demonstrated at last year's G2E show. We expect these improvements in the commercial version of these new products will generate an even higher level of excitement at this year's G2E show.

"Players and operators alike will enjoy the enhanced gaming experience that CPU-NXT enables our game designers to achieve, with advanced graphics and enhanced sound technology, faster game play and deeper bonus round features than previously offered in our legacy slot machines," Continued Gamache." Visitors to our booth need only look at the sensational multi-line video games, poker games and wide area progressive products, as well as the reel-spinning technologies we are introducing, to understand why we are excited about the future."

CPU-NXT Operating System

Through the utilization of a PENTIUM class processor, CPU-NXT enables faster game play, provides intricate graphic resolution and provides a significant increase in memory capacity. CPU-NXT allows for full support of many features and levels of functionality that casinos and players have come to expect in a slot machine, including: dual host communications, multi-denomination gaming, tokenization and ticket-in/ticket-out capabilities, and compatibility with all major slot tracking systems. CPU-NXT also allows customers to quickly change game themes when needed by simply changing the flash card and glass art.

- Continued on page 24

TechFest 7 TechFest 7 TechFest 7

Atlantic City, NJ - October 21, 22, 23 2003

Make plans today to join the gaming industry's top engineers, technicians, technical writers and instructors for 3 days of technical seminars and presentations that will enhance your performance as a technician and dramatically increase your value to your employer.

TechFest 7 will be held October 21-23, 2003 at the Atlantic City campus of the slot tech training specialists at Atlantic Cape Community College. For more information about the college, visit their website at http://www.atlantic.edu/casino/slot.shtml. Registration fee for TechFest 7 is $390.00 per person and includes lunch each day.

This is a technical presentation. The TechFest is geared for working slot techs and technical managers who are looking for a way to make a dramatic improvement in their understanding of video slot monitors, touchscreens, bill validators, hoppers and more with no-nonsense technical presentations from:

- **Coin Mechanisms, Inc. - Coin Comparitors**
- **Mars - Bill Validators**
- **3M Touch Systems - Touchscreens**
- **Seiko - Ticket Printers**
- **IDX - Coin Validator**
- **Money Controls - Coin Validator/Coin Hoppers**
- **JCM - Bill Validators**
- **GPT - Bill Validators**

- PLUS - A special instructional series on video slot monitor repair presented by Randy Fromm

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TechFest is for slot techs of all skill levels, from novice techs who want to learn the basics of BV and hopper maintenance to advanced techs that need to brush up on monitor repair.

Schedule of Events

Events subject to change

Tuesday, October 21st, 2003

9:00 am - 12:00pm
How Monitors Work - Part 1
Theory of Operation - Beginning level

1:15pm - 3:15pm
Mars Electronics, Inc. - BV troubleshooting and repair

3:30pm - 5:30pm
Seiko Printers - Printer troubleshooting and repair

Wednesday, October 22nd, 2003

9:00 am - 12:00pm
How Monitors Work - Part 2
Narrow Down the Problem - Intermediate Level

1:15pm - 3:15pm
3M Touch Systems - Touchscreen troubleshooting and repair

3:30pm - 5:30pm
Coin Mechanisms, Inc. - Coin Comparitor technology and repair

Thursday, October 23rd, 2003

9:00 am - 12:00pm
How Monitors Work - Part 3
Circuit Analysis and Component Level Troubleshooting - Advanced Level

1:15pm - 3:15pm
Money Controls - Coin validator and coin hopper maintenance and repair.

3:30pm - 5:30pm
JCM - Bill Validator Troubleshooting and Repair

Visit the website at slot-techs.com for more information

Space is limited - Register today!

PLUS - IDX (Coin validators) and GPT bill validators
Dates and times to be announced

Bluebird Gaming Cabinet

WMS' new, award-winning gaming cabinet features a superior design and other innovations that bring a higher level of comfort, enjoyment and service benefits to players. Bluebird employs a sleek, ergonomic design and spectacular audio and video stimulus while setting new standards for quality and reliability, functionality and entertainment. The sound technology in the cabinet provides an audio experience never achieved before in a gaming cabinet. This technology will promote fuller immersion of tile player with fewer peripheral distractions resulting in a more engaging, emotionally enriched play - the perfect complement to the enhanced CPU-NXT driven graphics. Bluebird is easier and faster to service with 80% of the internal components interchangeable between upright and slant models.

For further information, contact:
WMS Gaming, Inc.
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Waugegan, IL 60085
tel.847.785.3000
fax.847.785.3058
wmsgaming.com

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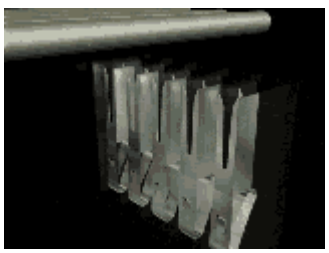
TechFest 7 in Atlantic City, NJ October 21-23



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FutureLogic Announces Gen2 Printer

Newest Printer Eliminates Player Interference, Delivers a Perfect Ticket Every Time with New Ticket Retention Feature

New functions for increased serviceability and functionality include tamper-proof tickets and increased ticket capacity.

At G2E, FutureLogic, Inc. introduced the Gen2 (PSA-66-ST2), the second-generation of its industry-leading PSA-66 line of thermal printers installed in more than 200,000 casino games worldwide. While maintaining the robustness and reliability of the PSA-66-ST, Gen2 offers a number of new features to help eliminate player interference and deter counterfeiters.

Gen2's pioneering "Intelligent Ticket Handling (ITH)" capability allows for all information to be printed prior to automatic presentation of the ticket, eliminating torn, smeared and crumpled tickets. In addition, Gen2's new "Tamper Resistant Ticket (TRT)" system allows altered and duplicated vouchers to be easily identified through its inventive printing and ink technology.

With an increased capacity of up to 900 vouchers, Gen2 holds up to 50% more tickets, minimizing machine downtime and labor costs associated with frequent paper restocking. Designed with easier access to the paper path, the restocking process takes just one step.

Technological improvements include no hassle firmware upgrades that can be made quickly with an easily accessible firmware port, ability to hot swap, and 768kB of flash memory to store over 100 promotional templates.

Other features include: * 100% backward compatibility with the PSA-66-ST * * Advanced thermal printer technology * * Single motion print head closing * Anti-pinch cable system * * Print head life of 320,000+ tickets * * High-impact, lightweight plastic for easier handling on the casino floor * * 2-year return to factory warranty

But the best feature of all (in the opinion of Slot Tech Magazine) is: NO MORE LITTLE BLUE LEVER!

Contact FutureLogic at 949.487.4829 for sales inquiries and 702.597.5355 for the service department.

FutureLogic also showed a new vertical printer at G2E

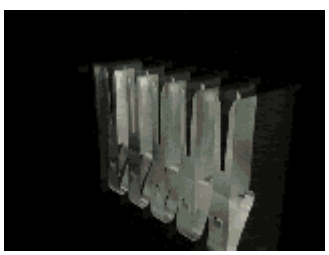
No more Little Blue Lever!

IDX Simplifies Coin Programming With XactData™ Coin Selectors

IDX, Incorporated, manufacturer of the Xeptor line of coin acceptors, has just released another revolutionary product to simplify coin programming in the field.

The new Coin Selector series of coin acceptor programmers allows you to change the acceptance parameters in a coin acceptor at the press of a button. Coin programming has never been simpler. Thanks to innovative patent pending mathematical transformations that take place between the Coin Selector and the Xeptor, the new coin signature is downloaded and adjusted for minor component variations in the particular Xeptor resulting in user simplicity without compromising acceptance security, first time or any time. Because the data is transformed to the exact needs of the specific Xeptor this transformation technology is called XactData.

Programmable multi-coin acceptors have become popular in the industry for a variety of reasons, such as; a) when casino tokens are purchased more than once, the alloy of one of the later purchases may not be quite the same as the original, but both new and old tokens must be accepted, b) a government may make a radical change in the alloy composition of its coins, but both new and old coins must be accepted, c) some gaming machines, such as those used in video lottery, must accept multiple denominations, and d) the casino customer may require the acceptance of a promotional token in addition to the regular token. After carefully listening to slot techs, IDX designed the Coin Selector to simplify coin programming without sacrificing accuracy and security.



The advantages of using a Coin Selector include:

*** Save Time:** The press of a single button is much faster than passing numerous coins through a coin acceptor in a manual procedure to change its acceptance parameters, and particularly results in significant time savings when large numbers of coin acceptors must be changed.

*** No Errors:** The Coin Selector downloads a perfect set of coin signature data every time, eliminating the possibility of any manual programming error related to having the correct coin(s), pulses, or techniques.

*** Better Accuracy:** The IDX coin signature database is produced using a broad range of sample coins to ensure proper centering and width of the acceptance windows for each parameter so that inaccuracies from using a non-representative sample set of coins are eliminated. XactData technology then ensures proper adjustment for each Xeptor.

*** Complete Profile:** Many coins have multiple personalities, such as the Canadian nickel with three radical changes to its alloy compositions in the past 25 years. Still, a single Coin Selector button allows you to download all three signatures without the need to find representative samples of each for hand programming.

*** Copy & Clone™:** When you want to program an Xeptor for a coin signature not provided by one of the buttons on the Coin Selector, this handy feature allows you to copy the coin signature data from a manually programmed Xeptor, and then clone as many other Xeptors as you like to operate with the same XactData. * Highest Security: XactData technology assures tight acceptance windows immediately after downloading coin signature data from a Coin Selector. The Coin Selector also deletes all other coin signatures previously programmed into the Xeptor coin memory.

IDX chief executive James Halsey explained: "We spend a lot of time with slot techs in the field; training them, helping them, observing how they use our products, and listening to them tell us what would make their jobs easier. The new Coin Selectors were then designed with their input primarily to save time and reduce errors in programming large numbers of Xeptors without sacrificing either acceptance or security performance. We also designed them so they will never become obsolete. In addition to being able to download updated coin signature profiles to the Coin Selectors, we created Copy & Clone technology for them so slot techs can manually program one Xeptor in any way that they like, push a button to copy it into the Coin Selector, then using it to clone other coin acceptors also at the push of a button. Coin programming has never been so simple!"

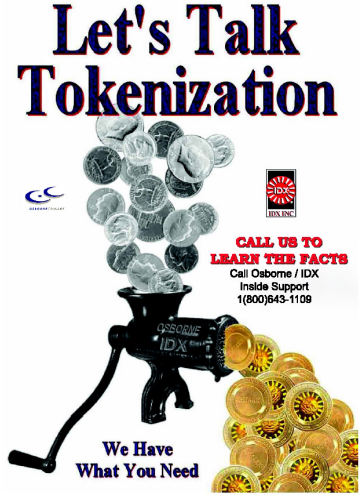
Halsey further commented "Based on initial reaction, we believe that our patent pending Copy & Clone feature will prove to be one of the Coin Selector's most important features. It lets the slot techs have the flexibility and control over what they need to do, and lets them get it done right now, very quickly and accurately."

The importance of security to satisfy the needs of different properties and gaming jurisdictions has also been well considered. Coin Selectors may be configured for either "Secured" or "Unsecured" operation. In the Secured configuration, once the Coin Selector has been used with an Xeptor, the Xeptor will be secured from manual coin programming unless the Coin Selector is attached, thus acting as an electronic access key. In addition, the Copy and Clone features may individually be enabled or disabled to further control authorization of personnel to make coin programming changes.

Coin Selectors are compatible with V4.0 or higher firmware for Xeptors. Coin Selectors are currently available for the recently released Xeptor models X-20 and X-22, which were designed specifically to detect the clad alloy layering in US, Euro, Canadian and many other government issued currencies to provide the highest possible security against slugs. Coin Selectors will also be available for the model X-60 when it is soon released. It will supersede the large denomination X-Mark reading model X-50, adding a few more features and being fully integrated as a single piece unit. Coin Selectors for the model X-10 will become available in late 2003. Standard versions of the Coin Selector are already available for the US, Canadian, and Euro coin sets, and versions for the currencies of other countries will be made available as requested.

For further information, contact:

IDX, Incorporated
400 West Cedar Street
El Dorado, AR 71730
Phone: 1-800-643-1109
FAX: 1-870-862-3472
sales@idxinc.com
http://www.idxinc.com/selector.htm



Above: Under the umbrella of Advanced Electronic Systems, Inc. (AESI) - In terms of peripheral devices, this booth was at the center of attention on the show floor, featuring bill validators from MEI, monitors from Kortek, ticket printers from FutureLogic and even a pretty amazing glasses-free 3D monitor from StereoGraphics.

Left: Speaking of Kortek, if you're looking for Kortek monitor repair, you'll find it at Casinotech in Las Vegas. That's Jennifer Hart and David Copron chatting about monitor repair with Two Rivers Casino's Matt Wynne. David is very helpful on the telephone when it comes to troubleshooting assistance as well.

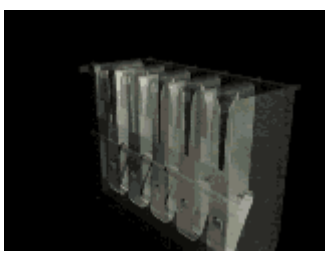
Above: Former JCM spokesman Tom Talbot is all smiles as he discusses the Microcoin validator and his new position as head of the tech training department. On the left is marketing and sales manager Robert Bird, who is all smiles because they now have Tommy Talbot working for them!

I promised Himec's general manager George Makise (left) that I would be certain to publish his photograph in Slot Tech Magazine this year. Himec manufactures an interesting and unique coin hopper that accepts different types of coins without conversion. Unfortunately, George, a detailed look at your product will have to wait until next month when there's more room in the magazine! With him are Himec president Tadanori Maki, manager Jason Lim and assistant manager Hideko Farmer.

Right: Armando Gomez is the tech trainer for Money Controls. He will be presenting at TechFest 7 in Atlantic City on October 23rd, 2003.

Above: MCM Electronics showed a variety of products, including replacement CRTs for video poker monitors, soldering rework tools and surveillance equipment. Of course, they carry a ton of other stuff as well.

Left: Slot Tech Magazine subscribers Dmitry Lizenko and Volodymyr Gladkyy of Metro Jackpot stopped by the Slot Tech Magazine booth to say hello. Was it worth coming all the way from Kiev, Ukraine to attend G2E? "Да. Будет хорошей выставкой."



Above: Sencore makes some of the world's best test equipment for monitor repair. That smiling face belongs to tech trainer Gary Moranville.

Above: At the Kimble (Ireland) stand, longtime Las Vegas industry mavins Connie Koplow and Michael Wichinsky of Gamemasters visit with Jim McCann and Martin Woods. Kimble was showing their new "Speed" PCB for slot machines, as featured in last month's Slot Tech Magazine.

Right: Jack Geller and Dave Kubajak of JCM. I was so happy to see these guys again, that I totally forgot to look at the Tovis monitor, which was the actual reason for my visit to the JCM booth. Oh well. Perhaps I can get them to send me a sample for review in a future issue of Slot Tech Magazine.

Right: Ceronix's Don Whitaker discusses their extraordinary new product (a touchscreen monitor without a touchscreen, if that makes any sense to you) with Pentranic's Harry Clarke of Livingston, Scotland. Look for a feature article on "CerTouch" in a future issue of Slot Tech Magazine.

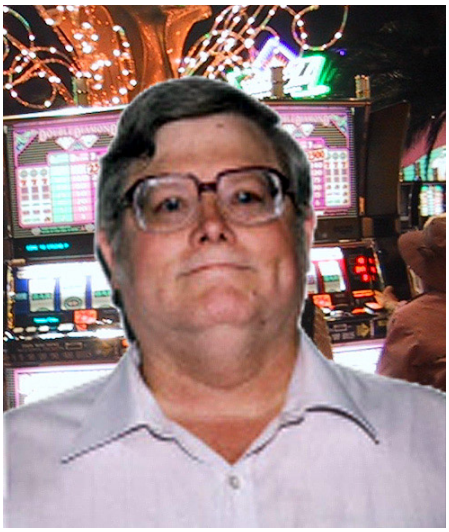
Above: What do you sell when your company is named "Coin Mechanisms, Inc."? Why, buttons, reels and lamps, of course! VP Rick Currie and president Stanley Pierz show off their new line of Gamesman products (not to be confused with Money Controls' Gamesman hopper). These are some damned sexy buttons, I gotta tell you.

Above: Slot Tech Magazine's patron saint, Frank Happ and the team from Happ Controls and Wholesale Electronics.

Above: In addition to their new "jam resistant" bezel, Ithaca showed a remarkable new two-color thermal printer at G2E. Look for a feature story on this amazing new device in next month's Slot Tech Magazine.

Above: Asahi Seiko showed their line of hoppers and coin validators.

Wells-Gardner showed their line of digital monitors for slot machines. From the left, that's Bob Lube, Marty Glazman and Tony Spier who, despite the casual appearance, is actually the CEO of the company.



Williams Power Supplies

By Herschel Peeler

A lot has been brought up concerning Power Supplies in general on the Slot Tech and Bench Tech forums. Slot Tech magazine has put out more than a few articles on how power supplies work both in general terms and specific power supplies. Here is yet another. This one covers switching power supplies in general, concentrating on how and why they fail. In particular, we will go over Williams power supplies.

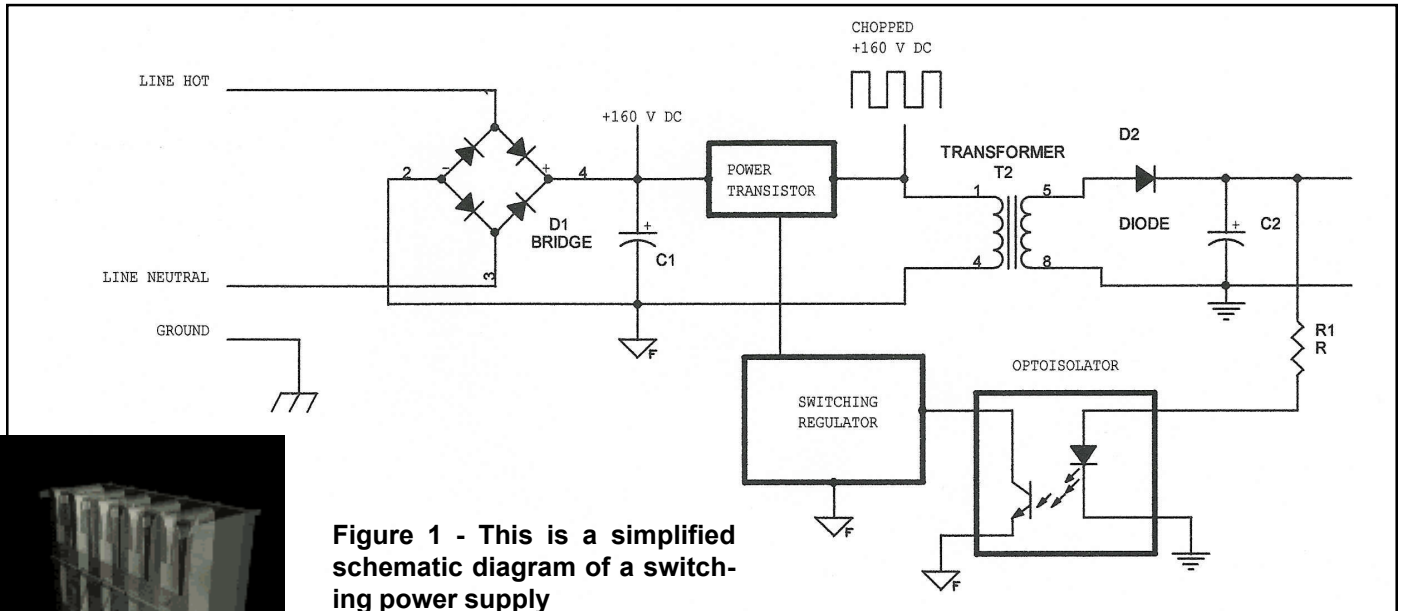
Switching Power Supplies

The general design used for the switching power supplies used by Williams are pretty straightforward as switching power supplies go. Williams did not design the power supplies they use, so don't blame Williams for their problems. They recently changed the vendor they use for their supplies. The specs look good, but it will take time to determine if the change will be an improvement.

The incoming 110 VAC line is rectified to produce a high DC voltage. Around +160 Volts. This voltage is chopped into pulsating DC by a power transistor. A switching regulator circuit controls the power transistor. This regulating circuit gets feedback on how the output voltage is doing by some sensing circuit simplified here by the optoisolator. (Very simplified).

There are various schemes to control the power transformer. One of them is the Pulse Width Modulation method. The regulating circuit varies the pulse width of the chopped high voltage DC. This change results in different voltage out of the transformer and in doing so regulates the output voltage.

In addition to regulating the output voltage with changes in output load current, the regulator also regulates the output voltage with changes in input voltage, and here is



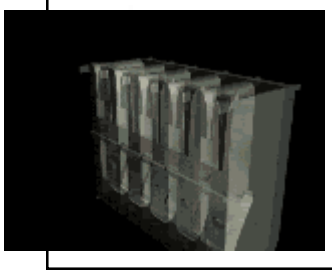


Figure 1 - This is a simplified schematic diagram of a switching power supply

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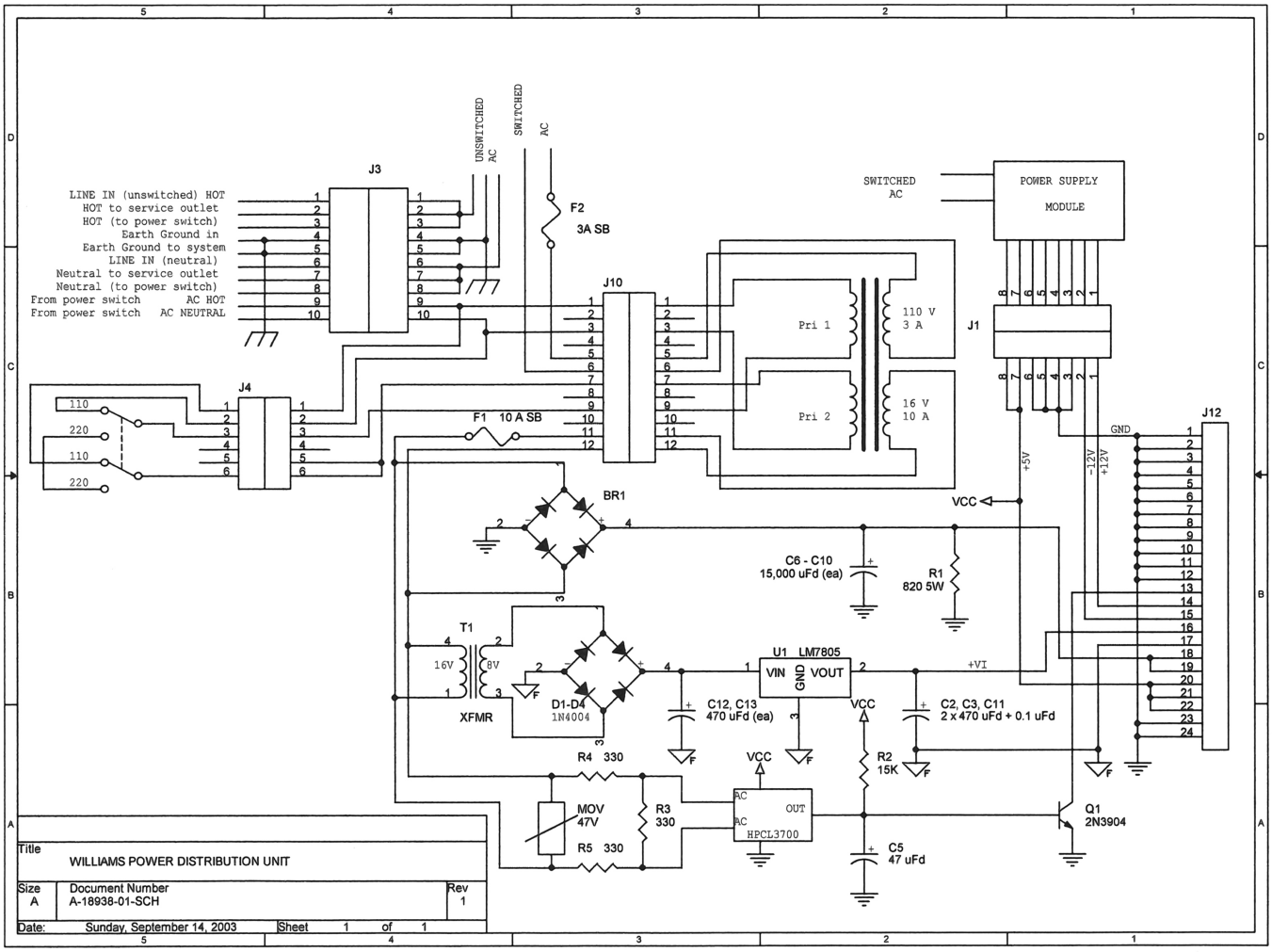
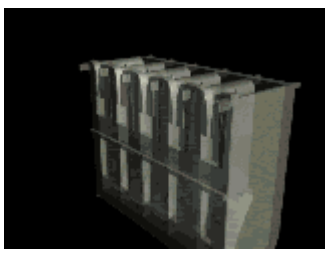


where many come into failure. Note that there are three ground systems. The AC line (Earth Ground), the Rectified Line AC ground that stops at the transformer, and the output ground circuit (Logic ground).

Failure Modes

As AC input voltage rises, the chopped high-voltage DC is given a narrower pulse width, keeping the output at the regulated voltage. The power transistor actually spends less time on and runs cooler at slightly elevated line voltages.



There is a higher voltage across the transistor, but it is turned off during this period and no current is going through it, so it dissipates little power as heat. When the line voltage runs lower than normal, the power transistor stays on longer (wider pulse-widths out) trying to keep the output voltage high. When line voltage drops considerably for extended periods, the power transistor actually gets hotter. There is voltage dropped across the power transistor with higher current running through it. The result is more heat being dissipated by the power transistor.

As transistors get hot, they are more prone to failure for two related reasons: The excessive heat causes more "minority current carriers" in the transistor, which causes it to conduct more, causing more heat, causing more conduction... until it just plain melts into a glob of silicon. If this condition persists, gas is created in the silicon. With no where to go, the case is ruptured and the gas escapes.

Related to this is problem number two. When we raise the temperature of the transistor, its breakdown voltage decreases. At operating temperature, the transistor may withstand 400 Volts. As temperature increases, this voltage tolerance decreases, and may easily decrease to below the high DC voltage from the rectified line.

If we put this power supply (any power supply) in a poorly ventilated box and run it at lower line voltages, it is going to fail. They all will. Not just Williams'. Other failures occur due to the electrolytic capacitors drying out but that's a well-known story I think. Heat is their enemy also.

Which bring us to the subject in particular, Williams power supplies. Williams games have a Power Distribution Unit with a few variations on the theme. They all have about the same design. We will go over one, and what we cover should be easy to apply to the others.

There are two basic assemblies inside the PDU. A large board with some power supply circuitry on it (and two fuses) and a power supply module; a switching regulator much like the one previously covered.

AC comes into the PDU on J3, as shown in the Williams schematic in the upper left corner of the schematic. It comes in as raw line voltage (unswitched), and is distributed from J3 back out to the Service Outlet ("unswitched") and to the power switch. Anything that retains power even when the game is turned off gets its power from here (Player Tracking systems, for instance). After going through the Power Switch it returns to J3.

The switch-controlled AC goes to yet another switch that is used to configure the two primaries of the transformer. For 120 Volt operation, the two primaries are configured in parallel. For 240 Volt operation, they are configured in series.

The power transformer has two secondaries. One is 110 Volts AC at 3 Amps for "Switched AC" circuits. Anything that runs on 110 VAC and comes on when you flip the power switch gets its power from this line. Note that since this is the output of a transformer, ground is isolated. Fluorescent lights, hopper, and most of all OTHER POWER SUPPLIES get their power from this line. There is a 3 Amp fuse on the PDU circuit board that feeds current through this line. Please note that the power supply to the Top Box is fed from this fuse. When the Top Box power supply fails, it often blows this fuse also. The other secondary is about 16 Volts at about 10 Amps. There is a 10 Amp fuse on the PDU board that feeds these circuits. In older versions these two fuses are soldered to the board. On newer versions they are on fuse holders.

The 16 Volt is rectified to provide +18 V DC. This is filtered by five large (15,000 uF) capacitors, represented as one capacitor in the schematic. R1 is a bleeder resistor across these capacitors to bleed off the charge of these capacitors when power is turned off. The 16 VAC also feeds a small +5 Volt regulator on the PDU board that provides power to the interface circuits of the game, named "+VI." This power supply is isolated from the other circuits by a transformer that steps the 16 VAC down to 8 VAC.

Power Failure Circuit

Another circuit the 16 Volt line feeds is a Power Failure sensing circuit. This circuit is built around an optoisolator, and HCPL3700. This circuit is described in an attached data sheet. The HCPL3700 is designed specifically for this type of an application. It can take a DC or AC signal and provide an isolated output signal. The AC and DC inputs are on one ground system. The Vcc, Ground and output are on another ground system. Light carries the signal between the two with no common reference to ground. This is the primary purpose of optoisolators.

The 16 VAC is applied to the AC inputs of the HCPL3700. This causes the LED to blink at a 60 Hz rate. This signal turns on the phototransistor, making it turn on and off at a 60 Hz rate. This gives us an open collector output that gets pulled to ground 60 times a second. On the output is an RC circuit. As long as we get every AC cycle, the output of the HCPL3700 keeps capacitor C5 discharged. If we miss a cycle or two C5 builds up a charge, turning on Q1, which feeds to the Reset sensing signal of the CPU (Logic Board). We have another potential flaw here. There is no current limiting capability built in to the HCPL3700 output. When the HCPL3700 goes low, the total charge on C5 gets dumped into the output of the HCPL3700. The

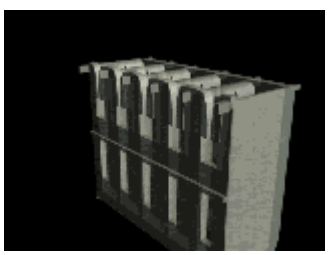
HCPL3700 does have a notable failure rate. Keep a few in stock.

This circuit is particularly difficult to troubleshoot for a number of reasons. It is only activated on power fail, and the output is open collector. With no load resistor on it, it always appears to be low. We will cover troubleshooting in a minute.

Main DC power for the game comes from a power supply module mounted on the PDU board. This power supply generates the +5, +12, and -12 Volts used by the game. All of the power supply outputs and signals feed to the game through J12. This power supply is power from the Switched AC line voltage.

On the I/O Board is a row of LEDs that are visual monitors of the outputs of these power supplies. Left to right, they are "+VI", "+12V", "-12V", +5V", and "+18V."

Worth noting is that there are two types of transformer connections. The transformer with the 12-pin connector is the older version. The newer version has a 16-pin connector. The same part number is quoted for the transformer in either case, so I don't think there is difference in capability. Lead length of the wires is the same. I confess I never asked why the difference in connectors.



FAIRCHILD SEMICONDUCTOR®

AC/DC TO LOGIC INTERFACE OPTOCOUPLER

HCPL-3700

DESCRIPTION

The HCPL-3700 voltage/current threshold detection optocoupler consists of an AlGaAs LED connected to a threshold sensing input buffer IC which are optically coupled to a high gain darlington output. The input buffer chip is capable of controlling threshold levels over a wide range of input voltages with a single resistor. The output is TTL and CMOS compatible.

FEATURES

- AC or DC input
- Programmable sense voltage
- Logic level compatibility
- Threshold guaranteed over temperature (0°C to 70°C)
- Optoplanar™ construction for high common mode immunity
- UL recognized (file # E90700)

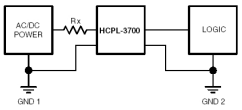
APPLICATIONS

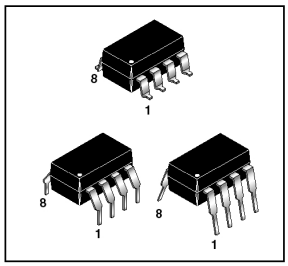
- Low voltage detection
- 5 V to 240 V AC/DC voltage sensing
- Relay contact monitor
- Current sensing
- Microprocessor Interface
- Industrial controls

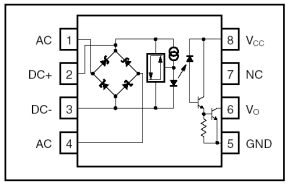
TRUTH TABLE (Positive Logic)

Input	Output
H	L
L	H

A 0.1 µF bypass capacitor must be connected between pins 8 and 5.







ABSOLUTE MAXIMUM RATINGS (No derating required up to 70°C)

Parameter			Symbol	Value	Units
Storage Temperature			T_{STG}	-55 to +125	°C
Operating Temperature			T_{OPR}	-40 to +85	°C
Lead Solder Temperature			T_{SOL}	260 for 10 sec	°C
EMITTER	Average		I_{IN}	50 (MAX)	mA
Input Current	Surge	3 ms, 120 Hz Pulse Rate		140 (MAX)	
	Transient	10 µs, 120 Hz Pulse Rate		500 (MAX)	
Input Voltage (Pins 2-3)			V_{IN}	-0.5 (MIN)	V
Input Power Dissipation		(Note 1)	P_{IN}	230 (MAX)	mW
Total Package Power Dissipation		(Note 2)	P_T	305 (MAX)	mW
DETECTOR					
Output Current	(Average)	(Note 3)	I_O	30 (MAX)	mA
Supply Voltage	(Pins 8-5)		V_{CC}	-0.5 to 20	V
Output Voltage	(Pins 6-5)		V_O	-0.5 to 20	V
Output Power Dissipation		(Note 4)	P_O	210 (MAX)	mW

Building a test fixture

Why build a separate test fixture? For one thing, the Williams test fixture mounts the power supply toward the back of the cabinet, much like the game. I would rather have the power supply out in the open so I can troubleshoot it disassembled if desired.

Second reason… I see no wisdom in putting a known bad or suspected bad power supply in a game or full game test fixture, endangering the game or test fixture. I much prefer bench testing power supplies on a dedicated fixture.

The test fixture we use to bench test the Williams PDUs is a simple creature as test fixtures go. It consists of a 1" x 12" board about three feet long. The monitor LEDs on the I/O board were duplicated and put on a small circuit board on the "1 x 12." Originally, a 1" x 12" particle board was used. The transformer is so bulky that it can crack a 1" x 12" particle board. If you build one, use real wood.

The transformer mounts at one end. The circuit board with the LEDs is at the other end. Across the long edge to one side are power resistors. Every power supply output has a load resistor on it so all power supplies come up under a load. The circuit board gives me visual indication of all power supply outputs. The AC Power Failure Sense also goes out to this board with a pull-up resistor on it so I can put a meter or scope on this output.

When testing a power supply, measure both the DC output voltage as well as the AC ripple. This is true for testing all power supplies.
To test the power fail circuit, I suggest shorting R3 in the schematic for a few seconds and confirming that the output (pin-13 of J12) goes high. In normal operation, you should see about 6 Volts AC across R3 and a small signal at 60 Hz coming out of the HCPL3700. Around 0.3 volts peak. Since this feeds the base of a transistor, it should never go above 0.6 Volts. If this signal goes all the way to VCC, Q1 is probably bad. If you get nothing (ground or DC) the HCPL3700 is probably bad.

AC voltages are monitored using "off-the-shelf" AC line monitors. Those little plug looking suckers with the three Neon Lamps in them. The Unswitched AC circuits should show normal. The Switched AC circuits should show an open ground line. That's normal. Remember this comes from the output of the transformer. I made an adapter that plugs into the 4-pin Molex Mini-fit jacks (J5, J6, J7, J8, and J9) to monitor these lines. These are the "Switched AC" outputs.

All in all, these are a very repairable assembly. Williams is good about supplying documentation. The parts are generally available. Since we got our test fixture up and running we have repaired 100% of the failures with very low cost parts. Worth repairing!

- Herschel Peeler
hpeeler@slot-techs.com

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Why back issues of Slot Tech Magazine are important to own . . .

Slot Tech Magazine is strictly technical. As such, the magazine's contents are not time critical. The repair information and technical data contained in past issues is just as valid today as it was the day it was published.

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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