

November 2011

SLOT TECH MAGAZINE

Slot Machine Technology for the International Casino & Gaming Industry

Checklists for
New Game Setup
and Conversions
Quick & Simple
Slot Machine Repairs
Oscilloscope

LIFE OF LUXURY
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FOUR DIAMONDS
\$1,001.33
DIAMOND
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EMERALD SAPPHIRE
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TechFest 23

December 6-8, 2011
Las Vegas, Nevada

On the cover: WMS slot
\$10 machines at G2E 2011

Slot Tech Magazine

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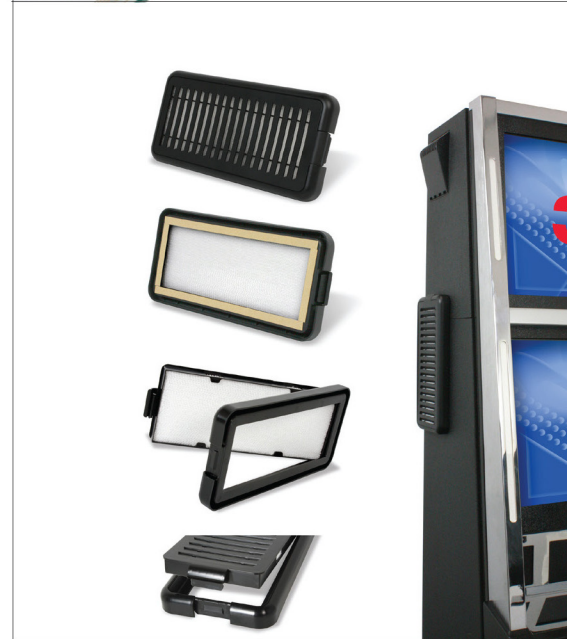
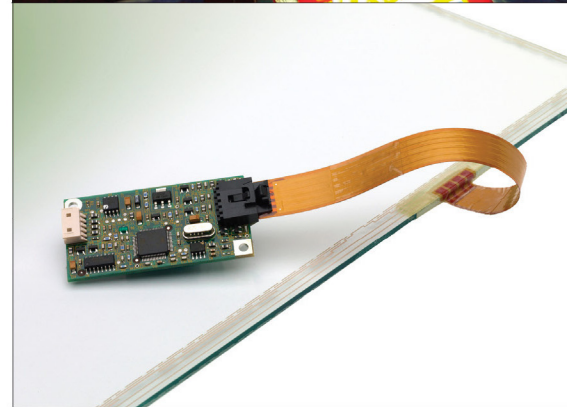
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Slot Tech Magazine Editorial

November 2011

Page 3-Editorial

Page 4-Checklists For New Games/Conversions

Page 10-Quick & Simple Repairs #80

Page 16-The Oscilloscope

Page 17-TechFest 23 Las Vegas, Nevada December 6-8, 2011

Page 22-Subscriptions

Why is this guy hugging this video poker machine? It's not even a winning hand!

Dear Friends of Slot Tech Magazine,

If you're into making last-minute plans for things, I'd like to encourage you to consider attending TechFest 23, December 6-8, 2011. I was late making the announcement about the event and it will be a smaller one with more "hands-on" than most.

This time, we're back in Las Vegas where it all started. I have published the class pictures from the first five events on page 17. There are just too many to print them all as over 1200 slot techs have attended since 2001. It has really been a blast to be a part of TechFest all these years and I have met a lot of slot techs from across the country and around the world at the events. We even held one in Austria (without the "L" and no Kangaroos).

One of the more challenging aspects of being a slot tech has little to do with troubleshooting and repair. Configuration "issues" abound in a modern casino. There is very little that is "plug 'n' play" in a slot tech's world. Instead, not only must all the hardware and sub-assemblies be configured for proper operation but the slightest error in monetization configuration risks huge losses for the casino. Checklists are a must in order to keep everyone on the same page. Our friends at Treasure Island Casino have contributed a couple of nice samples of checklists as well as a discussion of what goes into new machine and/or conversion setup and configuration. Thanks to Craig Nelson and the tech staff at Treasure Island for sharing this with us. The article starts on page four.

Thanks again to Pat Porath for his Quick & Simple Repairs, now up to #80. Yow! I have also included a reprise of the Oscilloscope. It's a digital world. Get used to. You might need to learn how to use a 'scope. Once you get past the frustration of NOT knowing what the heck you're doing (where'd the trace go?) it's actually a blast to use an oscilloscope PROPERLY to figure out what's going on in the circuit. This article follows along with my YouTube video on the same subject if you'd care to watch while you read. Look for the randyfromm channel. Thanks. See you at TechFest?

Randy Fromm
Randy Fromm - Publisher



Randy Fromm

Randy Fromm's Slot Tech Magazine

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**TechFest 23
Las Vegas, NV
Dec 6-8 2011**



By Craig Nelson and the
Slot Technician Department
Treasure Island Resort & Casino



Machine Conversions and New Game Setup

If you are reading this, you most likely have to either setup a new machine from scratch or you have converted an existing game to a new theme on your gaming floor. While these tasks appear fairly simple, due to the complexity of the slot machines in today's market, things can go wrong in a hurry if you are not prepared. Being proactive rather than reactive can provide some damage control when it comes to completing these tasks. In this article, you will be given some suggestions and precautions that have proven to help alleviate potential issues and mistakes.

Note: Before performing any of these actions, be sure they meet the criteria for your specific gaming jurisdiction.

New Machines

Note: Your level of responsibility may not require you to perform some of these tasks. First things first, as soon as the game purchase is ap-

proved and your management team has confirmation the new machines are being shipped, they should start gathering as much information about the games as they can. This will usually be done by the Slot Manager or equivalent.

Par sheets are going to be one of the first items that need to be obtained; the machine manufacturer will supply these via email, fax, mail, CD-ROM, or from their respective website (if available). Some jurisdictions require that a hard copy be on file for all games active on the gaming floor, while others just require that they be kept electronically. For the purposes of this article, it is suggested that both methods be utilized. Developing a system for organizing the par sheets is as important as getting the PAR sheets in the first place. Organizing alphabetically by game theme is most likely going to be the unanimous choice. As long as the method is consistent, it will work.

Next, the sensitive options must be determined for the set of new machines in question. These will likely be denomination, percent-

age, line configuration, max bet, and payout limits. In most cases, the Slot Manager or equivalent will make these decisions.

If your department hasn't already created a standard option sheet for each type of machine, do it now. Optioning machines on a whim or out of a notebook works to a degree but can lead to inconsistencies and mistakes. A system should be developed with unique identifiers for machine type so they can be easily accessed later. Sorting each configuration type by a group number has proven to work the best. If you are using multiple configurations with the same game theme, you can access the correct option sheet quickly and easily.

The option sheet itself could be as simple as a universal excel spreadsheet that specific data will be put into once those decisions are made. These sheets will be saved electronically for later use or could be printed and kept in a binder. Keeping this information accurate and up to date is very important and should be done by one person or a select group of people. An example of what



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NEW MACHINE CHECK LIST

Machine #	XXXXX	Location:	XXX-XX
Serial #	XXXXXX		XXX-XX
	XXXX	Date of Manufacture:	
Manufacturer:	MANUFACTURER	Model # :	
Game Name: PAYLINES	GAME THEME		
<i>PLAYER TRACKING</i>	<i>INITIAL/DATE</i>	<i>OPTIONING</i>	<i>INITIAL/DATE</i>
HARDWARE INSTALLED		CONFIGURATION	
WIRING		VERIFY ONSCREEN PAYTABLE	
TEST IN SHOP		VERIFY GLASS PAYTABLE	
		CONFIGURATION VERIFICATION	
<i>LOCKS</i>		<i>SOFTWARE ID'S</i>	
MAIN DOOR			
BELLY DOOR			
LOGIC BOARD ACCESS			
TOP BOX			
BILL ACCEPTOR ACCESS			
STACKER LOCKS			
DROP DOOR LOCK			
<i>OTHER</i>		<i>FINAL CHECKS & TESTING</i>	
PRINTER TEST		MACHINE ON-LINE	
BILL ACCEPTOR TEST			
TOUCHSCREEN TEST			
MISC TEST			
ISSUES FOUND			FIXED BY
ITEMS ABOVE WILL NEED TO BE TAILORED FOR YOUR SPECIFIC GAMING PROPERT			
THIS IS FOR EXAMPLE ONLY!			

This checklist is available for download from http://slot-tech.com/interesting_stuff/checklists/

an option sheet could look like is reproduced here. It is also available for download (to use as a template) from the slot tech website at http://slot-tech.com/interesting_stuff/check-lists/ . Your property's specific game mix and circumstances will deter-

mine what information it contains.

For the purposes of this article, we will assume that the new machines are new to your floor and nobody is familiar with them (other than the vendor of course). Depending on the dynam-

ics of your department, this would be the time to set them up in a controlled environment to get familiar with the operation of the game as well as get your sensitive information in order. This is also a great way of ensuring the product you put on your gaming

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floor is fully operational.

Another document that is very important is a new machine checklist. This checklist should be created to ensure each game is fully prepped to a pre-defined standard within your department. This sheet will be attached to each game and, as each task is performed, it will be initialed and dated by the individual that completed it. This ensures that nothing is missed during the whole process. It can be as simple or as detailed as needed.

Before proceeding any further, it is suggested that all the hardware (i.e. online system, locks, etc.) be installed before going to the next step. This will save valuable time later as most new machines need an online system to even operate without generating a plethora of errors.

Power up a game and do what is necessary to the point where it is ready to be optioned. The machine might need a RAM clear/key chip or equivalent in order to get it ready to be optioned. Then with a note book in hand (with or without a vendor) go through the option screens in order, at the same time you are writing down each option in detail as these will be used later to build the 'option sheet.' There will be many items that do not apply or that are used in other jurisdictions; those options will be usually left at the default setting. The most important and most com-

mon options will be serial number, date time, denom(s), line bet/percentage, max bet, payout limits, and your online system configurations. Each option set will be determined by multiple factors but these are the ones you should pay special attention to.

Once the machine is optioned to your liking, it should then be tested and played to ensure it will operate correctly when it hits your gaming floor for live play. This process is sometimes not realistic due to time constraints. This can be more of a 'perfect world' type of scenario. Once the new machines have been tested and satisfy all of your back of house requirements, they can then be installed.

Conversions

Just like new games setup, your management team needs to be as proactive as possible so you are prepared when the conversions arrive. Par sheets need to be obtained and your option set needs to be determined prior to them being installed. The main difference is that you will most likely already know how to navigate the game's option screens since you had set them up prior. It is not always fool-proof though, with the changing of a game theme there might be other changes that were made to menus or the options themselves, thus making it harder for the technician to navigate through them. You still have to be diligent in your

approach when it comes to anything "new."

The main battle that you are going to have with any conversion is being confident that the parts you received are complete and are going to work with the conversions. There will be conversions that are simple, such as the ones that have dual LCD screens and dynamic OLED buttons. Those games will almost always just require software. The games that require glass, button inserts, top box artwork, belly door artwork, RAM upgrades, etc. are going to be the ones that could give you trouble. The industry moves so fast at times that the manufacturers have a hard time with quality control. Either you will get more parts that you need or you will be left with half of a project done because you didn't get all the parts you need and didn't know ahead of time.

As a technician, you will have to use past experiences to inventory the parts that are included in the conversion and determine if you are going to have what you need. Glass and buttons are most common but glass insert decals, candle gels, RAM upgrades or any miscellaneous hardware might be missing. Going through the kits and inventorying them to the best of your ability will save you valuable time later.

Let's assume you have everything you need for your game conversion project; the machine(s) that

MANUFACTURER
DENOMINATION

PAYLINES
FOR EXAMPLE ONLY
GAME THEME

TYPE

SET 1	
CREDIT LIMIT	
CASH IN LIMIT	
OTHER DEVICES CASH IN LIMIT	
TRANSFER TO TICKETS LIMIT	
ALLOW CASH IN DURING GAME PLAY	
MAX WAGER	
FORCE HANDPAY	
ENABLE ATTENDANT CONTROLLED RESET	
W2G LIMIT	
MAX DISPLAY TIME	
HOPPER ENABLED	
MAX HOPPER W/O TICKETS	
MAX NOPPER W/TICKETS	
PAY THIS FROM HOPPER FIRST	
PAY COIN PORTION OF HANDPAYS	
MAX HANDPAY THAT CAN BE CANCELED	
SET 2	
BA ENABLED	
TILT REJECT MAX	
HARDWARE ERROR TILT	
STACKER FULL TILT	
STACKER OPEN TILT	
BILL JAM TILT	
US BILLS ACCEPTED	
ACCOUNTING DENOM	
DENOMS AVAILABLE	
DEFAULT DENOM	
HARD METER DENOM	
COIN ACCEPTOR 1	
COIN ACCEPTOR 1 DENOM	
DIVERTER BEHAVIOR	
HOPPERS DENOM	

COMM			
PROTOCOL NAME	PORT	ADDRESS	
SERIAL SAS1			ADVANCED
SERIAL SAS2			ADVANCED
SERIAL MISER 3			ADVANCED
			ADVANCED
ADVANCED			
PROTOCOL ENABLED			
COMM BOARD TYPE			
MIN. RESPONSE TIME			
SECURE HANDPAY ENABLED			
GAME PLAY EXCEPTIONS			
HOST SOUND SETUP			
HOST BA SETUP			
HOST MAINT. SETUP			
ENABLE INTERBYTE T/O			
DISABLE MACHINE IF HOST LINK IS DOWN			
PROTOCOL THAT CONTROLS			
VOUCHER IN/OUT			
CLOCK			
AFT BONUS TRANSFERS			
AFT DEBIT TRANSFERS			
AFT IN HOUSE TRANSFERS			
EFT TO MACHINE			
HANDPAY RESETS			
LEGACY BONUSING			
COUPON HANDLING			
ADVANCED			
VALIDATION			
ACCEPT VOUCHERS			
PRINT VOUCHERS			
PROMOTIONAL VOUCHERS			
FOREIGN RESTRICTED			

ADVANCED	
AFT	
OK TRANSFER TO TICKET	
OK TO PRINT RECIEPTS	
PARTIAL TRANSFERS	
ASSET #	
GAME	
GAME ENABLED	
DENOMINATION	
MAX BET	
MEGA JACKPOT ID	
MACHINE	
ATTRACT	
ENABLE GAME SPECIFIC ATTRACT	
ENABLE MACHINE WIDE ATTRACT	
MINUTES TILL ATTRACT STARTS	
MINUTES BETWEEN ATTRACT	
BELL	
CANDLE	
# OF CANDLE STAGES	
GAME COMPLETE T/O	
CLOCK	
SET TO CURRENT	
SERIAL # SETUP	
SET SERIAL & ASSET #	
SITE ID	
SET BY OASIS	
VOLUME	

This checklist is available for download from http://slot-tech.com/interesting_stuff/checklists/

are going to be converted are selected and the option sheet(s) have been created. This is where you need to make a crucial choice: do you go out and install the hardware i.e. glass, buttons, etc. (if applicable) or do you try to install the software components first? Even if you are 99.9% confident the software is complete and is going to work, you should always do the software portion first. This way you, will not install all the hardware and then have to switch it back if you

run into problems. The hardware (unless the software needs it) should be the last thing that is changed.

Once the conversion is completed, it will need to be tested to some degree. Your back-of-house operations are going to determine how this is done. Live money testing will prove to be the most effective. Use that money to play the game a bit and then cash out. In the meantime, check the meters to ensure

all systems are functional. Once you are satisfied that everything is working, the game can be put into service.

There will be a many variables during this process due to it being very dynamic. The premise of this article is how to stay as organized as possible during each of these tasks and having the documentation to ensure you stay accurate and organized in the future.

- Treasure Island



Quick & Simple Repairs #80

By Pat Porath

“Stacker Removed Error” Wouldn’t Clear on a Konami

I recently worked on an upright Konami game in which a “stacker removed error” wouldn’t clear. After swapping the UBA and the stacker box, I figured the problem must be in the bill acceptor housing assembly. The only way the error would clear was by pushing firmly on the stacker box so it would sit totally all the way into the housing. When the box is removed, there are two micro switches that can be seen. Slightly bending the metal tabs upward (so they show a “closed” position easier when a box is installed) was the only way that the error would clear. After that, the game was fine.



WMS Bonus Error on an “Egypt” Program with CPU-NXT1 Board

An error could occur with an “Egypt” program while in the bonus round if the game loses power, and the bonus credits may not go to the credit meter. If this does happen, verify last game recall before doing a hand pay. WMS is no longer selling this program, therefore no software updates will occur. The possible affected software with only the CPU-NXT1 type CPU are as follows: S936-000-1010B9, S936-000-1020B9, S936-000-1021B9, S936-000-1030B9, and S936-000-1050B9. More info can be found at wms.com, CSN number 11-116.

Bally new feature for preventing player confusion?

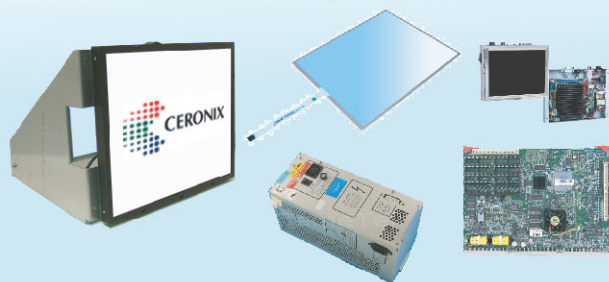
I personally thought this field advisory (number FAC2-11004) was interesting. “Feature for preventing player confusion when a tilt suspends a game machine or similar reel

game. Normal tilt operation of the Bally Class II machine suspends all activity until the tilt condition is resolved. Suspending operation with reel games such as “Green Machine” may cause player confusion because the reels can suspend at a point in the game where winning symbols appear on the reels. When the tilt clears, the reels resume spinning to completion, which is likely different from what was on the reels when the game was suspended. To prevent player confusion, an operator configurable option ‘iOPT6’ is available for machines, other than V32s, using operating system Class II OS V1.00.15M and later versions. This provides a feature to mask the reels area when a game suspends. Support for the V32 will be available in the next release of the OS (available around Dec. 2011).”

When a tilt happens, the screen mostly fills with a blue color, along with displaying the error. Definitely a neat feature. More info can be found at ballytech.com

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	Top Box	LB4014
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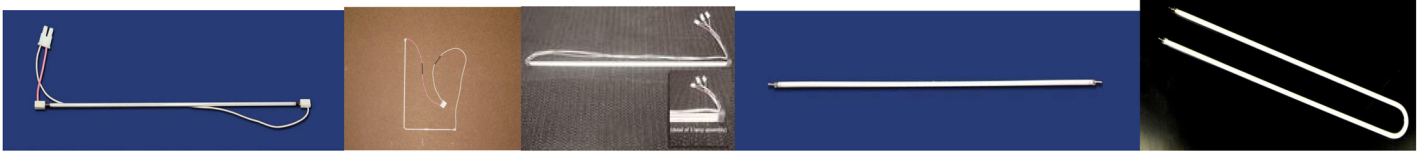
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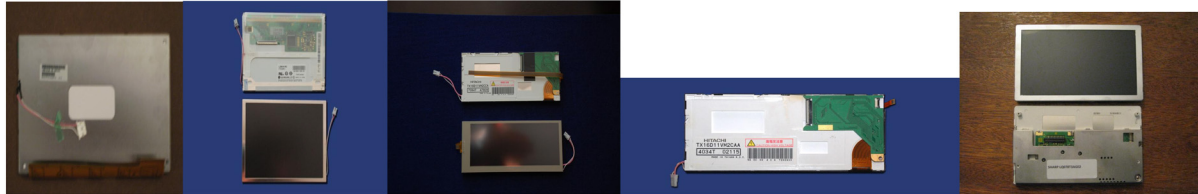
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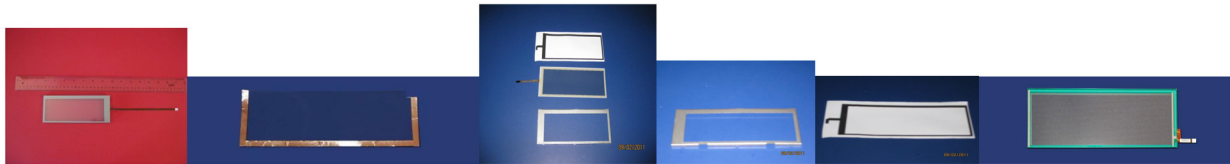
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#8610- Protective Mylar sheet W/ copper tape attached for 6.2" Hitachi LCD in IGT NexGen

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

FOR BALLY

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

#8680 -- Single cold cathode lamp assembly for Bally IView player tracking system 6.2 inch "IDW" LCD

#9890 – 5 wire touch screen for Bally IView 6.2 inch Hitachi LCD

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#1240 – 6.2" Hitachi LCD \$TX16D11VM2CCA

FOR KONAMI

#9780-"L" shape cold cathode lamp assembly for 7 inch AU Optronics LCD

#8550 – "U" shape cold cathode lamp assembly for 7 inch Sharp LCD

#1010 –7 inch AU Optronics LCD #C070VW02 for bonus screen

#1250 - 7 inch Sharp LCD #LQ070T3AG02 for bonus screen

FOR WMS (Williams)

#8520- Triple cold cathode lamp assembly for WMS slot machine with an 18" LCD monitor

#9300- Single RAW cold cathode lamp for WMS games with 19 inch LCD monitor

#8490 - 6.4" "LG" LCD #LB064V02 for bonus screen (does **NOT** come with touch screen)

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Two Super Simple Repairs

The first one was a complaint of a GEN 1 printer that was loose in an IGT upright game that was making the main slot door difficult to close. With a quick inspection as to why the printer was loose, it was missing three of the four small bolts that hold the printer frame secure in place. The small bolts were put back in place and the game was fine; no more loose printer. The second super simple repair was a complaint of another GEN 1 printer in an Atronic emotion game that wasn't feeding the paper correctly. As I arrived, I saw right away that the paper was being fed backward. The paper was turned around and fed in properly and the printer was fine.

There have been a few times where I worked on games for a period of time and the problem was simply a blown fuse. Or why won't the game accept bills? Because it is in the middle of a game in which a customer has placed a bet that has not been spun yet. Or what about a button complaint on a game where somehow it fell out of its socket and it only needs to be snapped back in place? I've also run into a couple of situations where I received a complaint of a game locking up for a small hand pay. The reason it locked up? The printer was out of paper! Recently I had an older Aristocrat with an Ithaca 850 installed in which the game didn't

seem to want to clear a printer paper jam error. After checking connections, reseating paper, rebooting the game, and swapping printers, simply reseating both the main and the I.O. board cleared the error.

WBA Grinding Badly in an IGT Slant Top

Upon arrival at the game, the slot attendant reseated the stacker box to have me listen to the bad grinding noise that it was making. No doubt the game had problems. I removed the stacker box and didn't really see anything out of the ordinary. Even though it sounded like the stacker box gears, housing gears, and or bill acceptor gears had broken teeth, I didn't see any physical problems. Next, I tried reseating the stacker a few times but the gears were still grinding. This time, I removed the stacker and used my small screwdriver to push down the "stacker pusher" in the box. It would barely move! When using a screwdriver, it should move in a downward position the length of about two inches. It seemed like something was jammed inside of the box. After a key was obtained, I opened it up but couldn't find any obstructions. Even with the "stacker pusher assembly" removed, I couldn't find the problem. I replaced the complete stacker box with a spare. Problem solved right? Well, not quite. The bill acceptor assembly still didn't sound very good, so the "bill acceptor housing" (also known as a "TR

stand") was replaced and the game was fine; it accepted bills and stacked them properly.

Editor's Note: Oh, great! Build up the suspense and then leave us hanging! Pat, did you ever find out what the REAL problem was?

IGT I-Game Power Problem

I was told the game only displayed "no signal" on the monitor for a second or two, then it would go black. Thinking logically, if a game has a power problem, why not start off first by replacing the power supply?

It was removed and replaced with a spare unfortunately without successful results. Both the bill acceptor and the printer were totally disconnected from the game and the power was turned back on once again without good results. Next, the main processor board was swapped with the game next door, the same thing happened yet again. The processor board lights would light up and "no signal" would appear on the screen for a second then they would go black. For the heck of it, I disconnected the power from the LCD and that didn't help either. Connections were also checked on the backplane board to see if any had come loose but they all looked good too.

Even though I was almost positive that the circuit breaker near the main 110v power input was good, that

was checked too, which was fine. The light bulb located in the stacker access door remained lit, along with the top glass bulb so neither of the ballasts appeared to be shorted.

What the world was left to inspect or disconnect? What have I heard of or what have I run across previously that would cause this type of failure? I sat for a bit and thought. Then it hit me. Could it be something as simple as a service light causing a failure of the whole game? I have seen it before a couple of times. It is very rare but I have seen it for myself. The top area of the game was opened up and the service light connector was disconnected. Once AGAIN the game main power switch was turned on. This time the power to the main processor board and LCD stayed on! It was a problem with the darn service light! I removed it from the game and gave it a quick inspection but couldn't see anything wrong. I connected it back up to the game while the power was on and nothing bad happened. Power was cycled on the game and it booted up as normal. For some unknown reason (fm repair?) now the service light was no longer freaking out the game.

IGT Older Video Slot Wouldn't Accept Bills

A call was received that an older IGT I-game slant top with an "Uncle Sam" program would not accept bills or tickets. The bill acceptor

November 2011

had already been swapped with the game next door and it still wouldn't work. Just to be sure, we swapped them again only with the same results. Different denominations and different tickets were tried too. A bill would accept into the transport assembly, make a single "click noise," then the bill would reject. Stacker boxes were swapped too but the error happened once again. Since the problem didn't appear to be a hardware issue, maybe there was a problem with the software? Game options, ticket options, bill acceptor options, and communication options were checked on the game. Nothing appeared to be out of the ordinary. The processor board was reseated and connectors were checked

behind the bill acceptor and still nothing looked out of place. Now what? The only things I could come up with were to try a RAM clear and, if that didn't work, to replace the main processor board. In the processor board area, I swapped the RAM chips with their original sockets to produce a RAM error. (Moved RAM chip A to socket B and chip B to socket A.) When power was turned back on the error appeared and the game options were set. Now it was time for the test. A \$20.00 bill was inserted and the bill acceptor took it on the first try. Awesome, the game was back in operation.

- Pat Porath
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The Oscilloscope



Love 'em or hate 'em, oscilloscopes are a way of life for many technicians. Here in the gaming industry, we can get away with lots of repairs without using a 'scope. Certainly, the vast majority of power supply repairs can be performed using just a digital multimeter and a capacitor ESR meter such as the CapAnalyzer 88a that you have seen advertised here in the pages of Slot Tech Magazine.

Likewise, most LCD monitor repairs don't require an oscilloscope for repairs. The inverters require replacement of caps and MOSFETS. Capacitors and DC-DC converters fix a lot of scalar (video) PCB faults (certainly not all). Lamp replacement is just lamp replacement. No electronic diagnostic skills required.

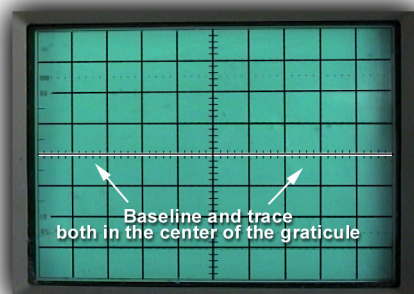
On the other hand, we live in a digital world and most digital repair requires the use of an oscilloscope. You must be proficient in using the 'scope if you expect to be good at digital electronics repair. Knowing how to use the oscilloscope is a completely separate skill set from anything else. It doesn't tell you what's

bad. It's just telling you what's happening in the circuit.

An oscilloscope is a graph drawing machine. It displays a simple graph that shows "voltage" in the vertical direction and "time" in the horizontal direction. The oscilloscope uses two different types of circuits to create the graph on the face of the display. First, we'll look at the vertical section. Next, we'll look at the horizontal section of the oscilloscope.

The Vertical Circuit

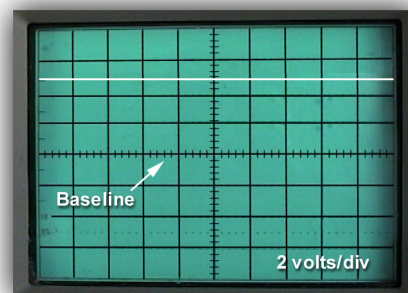
The higher the voltage, the greater the vertical movement of the display. The grid on the face of the oscilloscope (called the "graticule") helps you measure the amount of vertical movement of the display (see figure 1.)



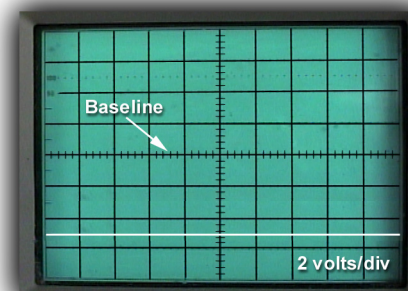
A vertical position control moves the "trace" up or down on the screen (see

figure 4.) With the input switch set to "GND" (this grounds the input, making the input voltage to the oscilloscope 0 volts) adjust the position so the trace is exactly in line with one of the horizontal lines of the graticule. This "baseline" position will vary, depending on the signal you're looking at. For the sake of discussion, let's start with the baseline in the exact center of the graticule (see figure 1.)

Applying a positive voltage to the input of the scope will make the trace will move up. (see figure 2.)



Applying a negative voltage to the input of the scope causes the trace to move down. (see figure 3.)



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Randy Fromm
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So, any positive voltage will be shown as being above the baseline while a negative voltage displays the trace below the baseline. Whoopee . . .

That's pretty stupid, isn't it? Surely the scope can do something else. Well, you can also measure voltage by using the graticule. The space between two adjacent lines is called a "division." On this oscilloscope, there are eight vertical divisions. To make more precise measurements, each major division is divided into five subdivisions.

A control called the "volts/div" switch or "vertical amplifier" sets the number of volts per division (see figure 4.) For example, if the control is set to 1 volt/div, then one volt applied to the tip of the scope probe will make the trace move exactly 1 division. +1 volt will make the trace move up 1 division. -1 volt will make the trace move down 1 division. If the volts/div switch on the oscilloscope is set for 2 volts/div, it requires 2 volts to move the trace just one division. If the volts/div switch on the oscilloscope is set for 5 volts/div, it requires 5 volts to move the trace just one division. You will see this "1-2-5" sequence repeated elsewhere on the oscilloscope.

For example, let's "scope" the three outputs of a typical power supply. I

have the oscilloscope ground connected to the DC ground of the power supply and the oscilloscope set to 2 volts/div. The baseline is still set in the center of the graticule.

Let's start by scoping the +5 volt DC output (see figure 2.) Do you see how the trace has moved up 2 and 1/2 divisions from the baseline? Since the vertical volts/division is set for 2 volts/division and the trace has moved 2 1/2 divisions, the voltage measures out as 5 volts DC. Since the trace moved up, we know that it's positive; +5 volts DC.

If we move the scope probe to the negative output of the power supply (see figure 3) we will see the trace moves 2 1/2 divisions again, but this time the trace moves down instead of up to indicate an output of -5 volts DC.

If we move to the +12 volt DC output of the power supply (see figure 5) the

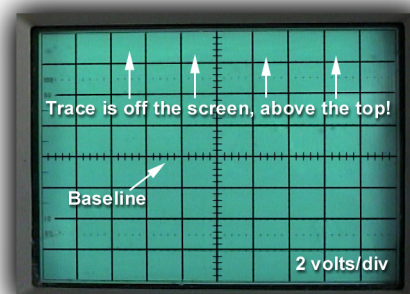
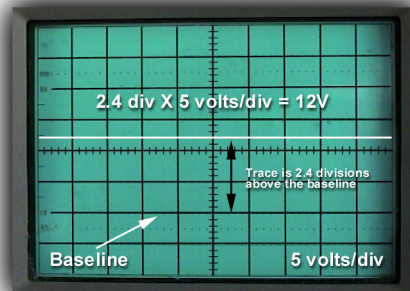


Figure 4. The vertical section

trace disappears! Where did it go? Scoping the +12 volt output with the baseline set to the middle of the graticule and the oscilloscope set at 2 volts/division puts the trace off the top of the display; two divisions higher than top edge of the graticule. Many oscilloscopes have a "beam finder" button. Pressing the beam finder will show you where the trace is regardless of where you have set the volts/division control. In this case, pressing the beam finder reveals the trace at the top of the display.

Let's set the vertical input to 5 volts/div. Anytime you reset the volts/division, you should check your baseline! Set the input to "GND" (see figure 4) and use the vertical position to pick a convenient line on the graticule. It doesn't

have to be the center line. In fact, it often is not. If, for example, I want to scope the +12 volt output of the power supply, I'll probably set the baseline down on the bottom somewhere (see figure 6.)



Since I'm not going to be looking at anything that's negative, the trace will not move down; only up in the positive direction! Now we see a little more than two divisions or +12 volts.

The maximum is 5 volts/div. That sucks because

even if you while channel 2 examines the data.

The oscilloscope cannot actually display both signals at the same time. There is only one "beam" in the CRT so it can only draw one trace at a time. The oscilloscope displays the two separate channels by "time sharing" the beam.

It does it in one of two ways. The first method is called "alternating." First the oscilloscope draws channel 1, then, after the trace has been completed from left to right, the oscilloscope displays the input at channel 2. When this happens very quickly, it appears that there are two simultaneous beams. This setting is best for displaying fast signals.

The other method of displaying both vertical

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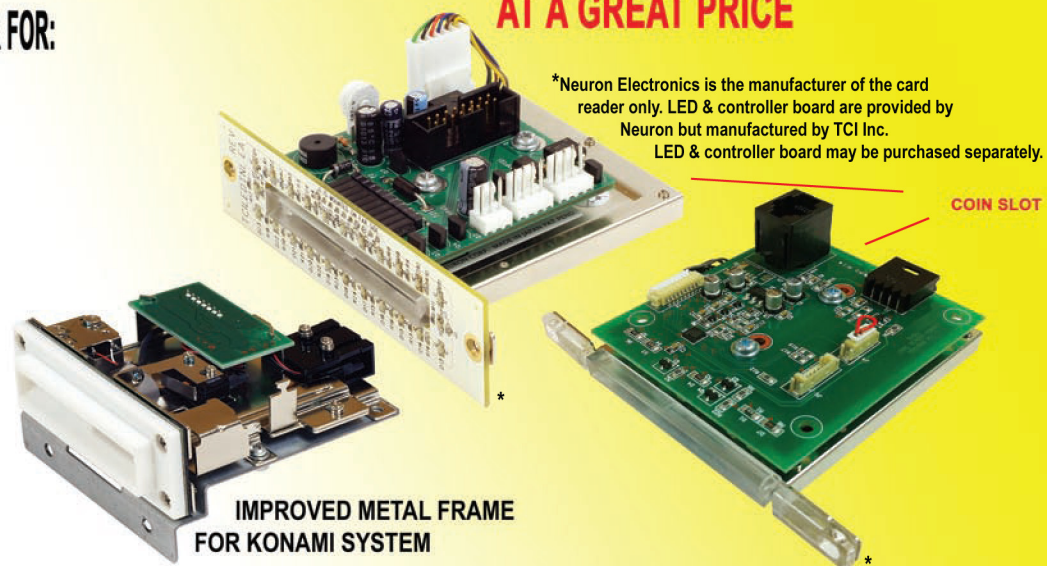
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channels is called "chopped." The oscilloscope will first display a portion of the channel 1 waveform, followed by an equal portion of the channel 2 waveform. The two input signals are chopped up into small bits. The chop rate in the Tektronix 2235 oscilloscope is around 500 kHz. This setting is best for displaying slow signals.

There is another vertical mode setting on this oscilloscope. It's called "add." This setting takes the input at channel 1 and adds it to the input at channel 2. The result is shown on the display.

At first glance the two vertical channels look identical but channel 2 has one extra button. It's called the "invert" function. When the invert button is pressed, the channel 2 input is flipped upside-down.

Why is this useful? Here are a couple of neat things you can do by using the invert button along with the "add" setting we just looked at. If these two functions are used together, the "add" function becomes a "subtract" function. It's called "common-mode rejection."

For example, there are two types of ripple in a switching regulator power supply. One is high frequency ripple at about 40 - 50 kHz. This comes from the switching action of

the transistors. Another is low frequency ripple at 60 Hz that comes from the 120 volt AC line.

If, for some reason, I want to look at just the high-frequency ripple, I can connect channel 1 of the scope to the output of the power supply, and connect channel 2 to the AC line. For the sake of safety, I would probably want to use a transformer or some other means to take just a small sample of the 120 volt AC line. I don't actually need the full voltage, just a sample of the ac power will do.

By inverting the AC input of channel 2, the unwanted AC component will be subtracted from the display, and I can look at just the high-frequency ripple.

This same function can be used to track down distortion in an audio amplifier. The input can be connected to one channel, while the output is connected to the other. By subtracting the two, any differences caused by distortion or phase-shift show up on the display. In a stereo amplifier, left and right channels can be compared and balanced the same way.

This oscilloscope has another control called "bandwidth limit." The real world of electronics is not nearly as clean as the theoretical world. In the



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real world, all kinds of high-frequency electrical “noise” can creep into your displayed waveform. Some of this noise is generated by the circuits themselves. Some comes from various outside sources. When engaged, the bandwidth limiter cuts the “bandwidth” or frequency range from 100 Mhz to 20 Mhz. This cleans up the display, giving you a sharper trace. Naturally, you won’t use this setting if you’re trying to look at high-frequency signals or signals with fast rise or fall times.

Another control in the vertical section is the Volts/div variable control. The variable control knob is in the center of the volts/div knob. Normally, you will keep this control in its locked, calibrated position. The variable control allows you to set custom vertical deflection factors, in between the calibrated settings. This function is useful if, for example, you’re working on an assembly line and you have to set a control on each unit so that a certain voltage is exactly 2.75 volts. Rather than having to count sub-divisions, you simply use the variable control so that 2.75 volts is exactly 2 divisions. Now all you have to do is adjust the unit under test so that the trace is exactly 2 divisions instead having to count sub-divisions.

Next Month: The Horizontal Section

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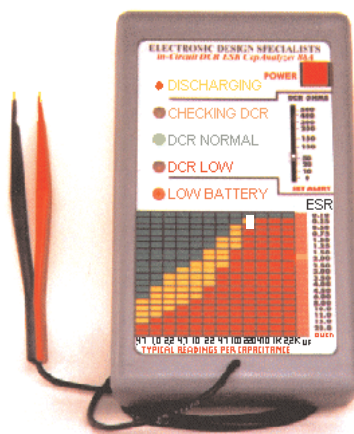
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About Randy Fromm: I am the publisher of Slot Tech Magazine. First published in 2001, Slot Tech Magazine is a monthly trade journal focusing on casino slot machine repair. I have been repairing electronics for the gaming industry since 1972. I really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