TechFest 10 is Coming!
Las Vegas, Nevada
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Slot Tech Magazine is an Official Publication of global gaming expo (G2E)

Operating slot machines in Russia is a lot like operating in Nevada. Some operators have built casinos like the one you see featured on this month's cover. Small slot arcades dot the urban landscape in cities such as Moscow and Saint Petersburg. Operators also run street routes with machine placement such as this one (r) at the domestic airport terminal in Moscow.

On the Cover: This Saint Petersburg casino has a snug and comfortable ambience that you just don't find in American casinos. Spotless and inviting, it was typical of Russian casinos both large and small.

Slot Tech Editorial


Randy Fromm

Here's your first lesson in reading the Russian (Cyrillic) alphabet. Take a close look at the cover of the magazine. The arched entrance leads to a really nice casino in St. Petersburg, Russia. Can you read its name? ВЕГАС? Here's how you pronounce it: B sounds like V, Г is the G sound and the C is always soft. It's a little strange at first but it didn't take me too long to discover the most important word of all, PECTOPAH (pronounce the P like an R and the H as an N. You know what to do with the C).

So, with this vast knowledge of the Russian Alphabet, let's visit Russia.

Russia has a preponderance of highly skilled technical workers who, in my experience, are both meticulous in their attention to detail and, on the repair side of things, quick to improvise an effective solution utilizing limited resources. Witness the Russian/Soviet space program and their ability to keep MIR aloft far beyond its projected life-span. While working on a project that involved preparing some USA amusement machines for export to Russia (destined for the Star Galaxy amusement complex) a Russian technician showed me how an ordinary piece of stranded wire could be transformed into an effective "solder wick" for unsoldering components from a printed circuit board. This guy was brilliant. In his previous job (under the old Communist government) he was an engineering technician at a fusion reactor research facility. Go figure.

This month, Slot Tech Magazine introduces you to Russian gaming giant, Unicum with a tour of their Saint Petersburg factory and a visit to their office in Moscow. You'll meet some of the staff and see how machines from Bally, Atronic and Aristocrat are put together, Russian style. You'll also read about a revolutionary new slot system that can completely eliminate the "back-end" support equipment required in virtually all modern casinos and replace it with a simple web browser. Part two of Slot Tech Magazine's visit to Russia begins on page 26.

Put 2000 slot machines in a room at a handful of amps each and you're bound to have power concerns. Add to that all of the other electronic equipment in a typical casino and you quickly can see that you need every ounce of juice you can get your hands on. Did you know that there is a nefarious, power-sucking waste factor that's heating things up and wasting power at your casino? Did you know that you can do something about it and gain back over 10% on your energy budget for your electronic thingies? Read about Harmonic Suppression Systems starting on page 18.

There is more of course but I'm out of room for this month so I encourage you to explore inside and enjoy yourself.

See you at the Casino.

Randy Fromm - Publisher

Randy Fromm's
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Atronic Cashline

By Kevin Noble

Cashline, the Atronic video slot machine, was introduced onto our gaming floor last April. At the time we had only eight games after a field trial was passed at a different site in Ontario. This was another chance to bring something different to our patrons, showing them once again that we will bring in the newest games approved by our Gaming Commission.

Now almost a year later, we have gone from eight machines to 36 machines in two different denominations. During the installation of all these machines, Jack Riley was the acting technical rep for our area and he was a great help. While a recent installation took place, we had to install 10 new BVA door optics on a 10-day field trial for the AGCO. We had to remove the cherry switch and install an optic board and harness into the hard meter board. This worked great until the soft count crew started breaking the optics right off the board, thus disabling the machines. With only a limited number of optics in circulation because of the field trial, these games had to remain down. The new and improved version had a guard mounted so the count team could not break the fragile little optic on the board. So far, this has worked great. I also had a chance to install three of the Universal Toppers on our games. I completed the first one and they do look good sitting on top of the machine with the eye-catching LEDs. After completing the first installation, the rest did not take long.

Atronic RAM Clear Procedure

1. Turn power off
2. Exchange MAIN EPROM U2 with MASTER RESET EPROM (RRES-09 EPROM)
3. Exchange PAYTABLE EPROM U6 with CONFIG KEY EPROM (CK-RDW-A-B EPROM or CK-RDW A-C)
4. Turn power on
5. Wait approximately 10 seconds for an audible signal
6. Exchange MASTER RESET EPROM with original MAIN EPROM U2
7. Turn power on
8. Wait approximately 10-30 seconds for a “CONFIG KEY Detected” message on screen.
9. Exchange CONFIG KEY EPROM with original PAYTABLE EPROM U6.
10. Turn power on
11. An error message “RAM ERROR” will be displayed.
12. Press and hold the red RESET BUTTON on the Main Board for approximately 10 seconds (audible signal)
13. Perform additional Software Configurations if required

Performing a Soft Reset

1. Switch Power off
2. Press and hold the reset switch
3. Turn on power
4. Hold the reset switch at least 10 seconds
5. Wait for the audible signal

Service Screen

1. Open main door
2. Press GREEN test button.

3. The screen will show several options for you to choose from.
4. Highlight the self-test option by using the left or right-lit buttons to move through the menu.
5. The screen will show all test functions available.
6. Highlight the test that you want to perform and press the center lit button.
7. The game will then perform the test and tell you the outcome. Some tests require input from the operator.
8. To quit the test mode press the CASH OUT button.
9. Close door to return to the game.

News and Notes

* SMIB Board communication line connects to P2
* 2 sets of RAM clear EPROMS
* CONFIG Key CK-RDW A-C EPROM is used for Babooshka, Crazy Fruits, Sphinx 2, Happy Happy Hippy, Three Wishes, Rock and Rollin, and Chickendales.
* CONFIG Key CK-RDW A-B EPROM is used for I.C. Money, Trucks and Bucks, Jockey Club, and Break the Spell.
* AB - Older machines (payables on the belly glass)
* AC - Newer machines (all equipped with sound cards)
* Program and kit are used for enabling the printer and/or progressive games
* Security EPROMS are used with each individual game to prevent burning new EPROMS
* Security EPROMS also controls the game EPROM U2
* Dipswitches are not recog-

Options:
Set Demon (set according to the game).
Set in Multiplier (set to 1).
Mechanical Meter 5 (set to Games).
Set Active Credit Limit (set according to the game).
Set Purchase Credit Limit (set according to the game).
Bonus Enable (set to Disable).
EFT (set to Disable).
Set Progressive Group (set to 0).
Commboard Required (set to NO).
Set Bill acceptor Type (set to JCM).

How Many Reel (set to 5).
How Many Lines (set to 9 or according to the game).
Which Bet Per Line (set according to the game).
Which Percentage Version? (Set according to the slot file).

Menu Setting: (Press the GREEN BUTTON to get into Menu setting)
Toplight:
Door: Top: OFF
Bottom: Slow Flash
Change: Top: ON
Bottom: OFF
Tilt: Top: Slow Flash
Bottom: OFF
Jackpot: Top: Slow Flash
Bottom: Slow Flash
Hopper Payout Limit:
Hopper Payout Limit (Set According to the game).
Change Language:
Setting to " English "
Double Up Set Up: (Only for CK-RDW A-C)
Double Disabled
Bill Enable:
Option not use
Animation Mode / Sound:
Animation Mode (set to ON).
Animation Sound (set to OFF).
Win Presentation:
Detailed Win Presentation (set to ON).
Jackpot Music:
Volume set High
System Lockup Options:
On System Lock: Credits Remain on Game.
Coupon Redemption:
Coupon Status: Disabled
Code length: 18
Sound Menu:
Sound Volume: 20 (Adjustable)
Reel Random Sound: ON
Set Celebration Limit:
Limit Status: Disabled
Upper Limit: None
Lower Limit: 1
Send Credits: To Hand pay
Change Token window:
Option not used
Denomination Window:
Option not used

nized on the screen because it is programmed into the software. (This was used for the old software (NVD) but there is an upgrade that uses the switches (USA).
* There are four lights on the power distribution board. They must be on constantly.
* Check fuse on backplane board. Sometimes they come loose, varying the +5 volt power.
* On the power supply, the 5 volt line was varying. If you get "Commboard not detected" errors, this could be the problem.
* There is a pot on the power supply to adjust the 5-volt line to 5.05 volt or 5.1 volt. Atronic says they took care of the problem.
* Ghost Jackpots cleared when the Comm board is replaced.
* Uses two key switches on the side of the game control the following functions: Audit (access statistical information), Jackpot (confirms hand pays and JP wins, but also activates remote credit function and the service game), Service (access test function and machine set up), and Resetting (reset tilts and clear machine data).
* The hard meters, the coin value, and limits must be configured after a RAM reset
* The CONFIG Key sets the pay table and percentage
* On the entry screen the main version, pay table version, graphic version and Config version is displayed.
* Newer versions of the game now have the BVA door optics.
* Some themes can support a universal topper for their round top, square tops, and slant top models.
* There is an option in the hopper test to empty the hopper.
* Once max credits are set, you need a RAM clear to change it.
* We constructed a cover over the line filter because of a blown board. After discovering coins slipping in behind and shorting out. (future upgrade)
* For the Province of Ontario, we have a new Technical Representative in Andrew Waskawich with Action Slots / Atronic. Andrew can be reached at Awaskawich@atronic.com

Overview

With a non-stop flow of new manufacturers and upgraded software consistently making it way through our site, Atronic has not stood still. They have continually kept pace upgrading their software as well as also adding an upgrade to the BV door with optics. We installed this new kit on a field trial that was then passed by our Gaming Commission after just 10 days. Atronic and our warehouse have scheduled an Atronic technician to come in, upgrade the BV door at all 22 sites in Ontario and install a new line filter cover.

Another upgrade consisted of new EPROMS, including the Communication Board version 08. When we first upgraded these themes, we were quick to find that when the machine went into a hopper tilt or hopper empty code, it made us hand pay all coins that were left to be paid out. We discovered that this new upgrade started using the DIP switches on the CPU board. In the old version, the switches were not used, so we paid no attention to what the Dips were set to. Once the switches were set correctly, we were able to clean up some small problems the slot attendants had brought to our attention in the older version software. We have not experienced any major problems with our Atronic machines but any minor problem we did encounter the company was there to listen and address whatever problem we encountered.

I did like many features about the machines. The main door panel is easily accessible, the coin head is simple to change, and the hopper has never had a problem. The logic box is right there when the door is opened and the boards are easy to remove and place back in. Atronic has come a long way since last April coming out with a whole new cabinet style machine in the E-motion. One day, when our site has these machines on our floor or I have the chance to go up to Burlington for training or prep work, I can write about yet another amazing product. Most important though are the interesting and useful facts I can pass on to you.

- Kevin Noble
- Knoble@slot-techs.com

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A Pleasant Time in San Diego

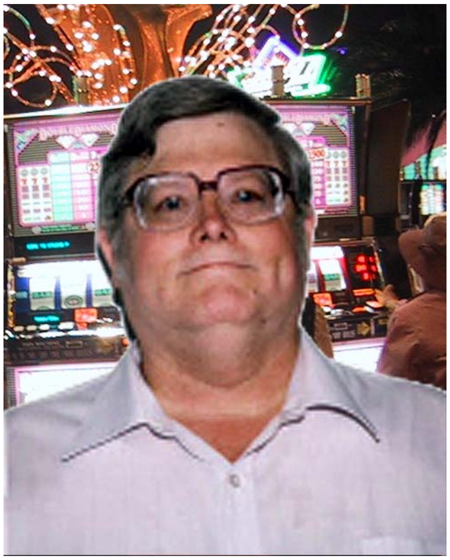
Giant three-day TechFests can be a lot of fun but there is something to be said for having the luxury of a small tech class with two full weeks of hands-on training. The Casino School, held in mid July, was sponsored by Sycuan Casino, located in Slot Tech Magazine's home town of El Cajon, California. Students came to the class from as far away as Washington and Illinois.

While the program focused on monitor repair, students also participated in presentations on FutureLogic printer repair (presented by David Oldham of AESI) and a full day of JCM bill acceptor repair, presented by company representative Dan Peterson. Also participating in the event was guest instructor Ramiro Limon on the subject of the repair of Ceronix monitors.

Above Left: Lori Peterson is looking forward to becoming a slot tech. The accommodating tech staff at Sycuan Casino scheduled special "Early Bird" sessions to take her and Elliott Jackson (another novice, shown above) through the basics that are not covered during the regular program.

Above: Dan Peterson (JCM American) shows demonstrates diagnostic and repair procedures for the company's WBA bill acceptor.

Below: Casino School graduates Lori Nesbitt, Justin Trout, Hugo Guzman, Elliott Jackson, Ray Cuero, Terri Prietto, Jose Sevilla, Jesus Garcia and Brian Cousins with Dan Peterson and Slot Tech Magazine publisher Randy Fromm.



Bally Hopper Control Board

Part 2 - Build a Test Fixture

By Herschel Peeler

Bench testing the Bally XS-1200 hopper is not hard. If you have a Bally test fixture you are in excellent shape. If compliance issues prevent you from having a processor board off the floor all is not lost. The hopper can come to life with LEDs, switches and two small circuits. All the circuitry except the power supply can fit on a small Radio Shack circuit board (276-150A).

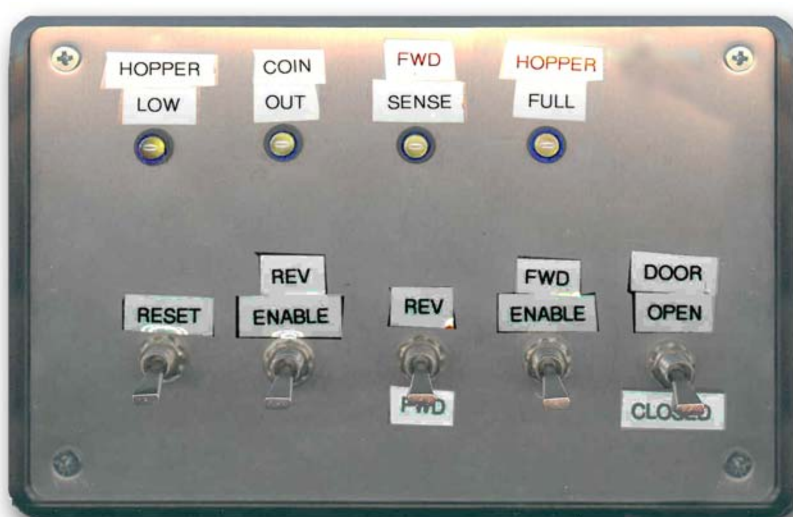
Referencing the schematic titled Bally XS-1200 test Fixture. To bench test the hopper we need to emulate the control lines coming from the game. We have five input lines, and possibly four output lines (only two of which are really important). All but one of the input lines can be driven from a plain switch.

For inputs we need:
Door Switch
Forward / Reverse
Forward Enable
Reverse Enable
Reset

The Forward Enable requires a trick but all the others can be done by a switch. The Forward Enable line is renamed on the board as "Game Pulse." It isn't obvious anywhere in the prints but this needs to be a 100 Hz stream of pulses. I suppose the intention is that no failure that was caused by a broken wire or short would result in the hopper paying out coins. Not a bad feature!

As can be seen by the schematic, all the switches feed straight to the hopper connector except the "Fwd Enable." Forward Enable removes the Reset to an oscillator. The output of the oscillator goes to the hopper as "Game Pulse."

Only two outputs are really used, although four are allowed for. "Coin Out" and "Hopper Full" are the only two typically used. "Forward Sense" and "Hopper Low" are often not used. Some schematics show these last two signals in use. Other schematics show them as not connected.



The LEDs used to monitor the outputs and the 100 Hz oscillator require 5 Volts for operation. This doesn't come off the board so you need to add a 5 Volt regulator to power these circuits. If you power this from the 24 Volts that the hopper requires the only power source needed is +24 Volts with current limitation. We use a Bench Power Supply that have a variable output voltage and variable current limit. See the picture of the 5 Volt regulator circuit and the drawing and picture of the control panel.

You can't get much simpler a design. At first attempt I tried to drive the "Fwd Enable" from a switch, expecting the signal to be as it appars, an active High level. Try as I may, the hopper would run backward properly but wouldn't go forward. A four o'clock phone call to Bally's usual help line was returned to me by eight o'clock the next morning with an answer about the fact that the Fwd Enable becomes Game Pulse which is a 100 Hz pulse string. Excellent response from them!

Operating Procedure

As built we have a Reset switch that emulates a signal from the game. We use it to clear error conditions. To run the hopper reverse, as if unjamming coins, we put the "Fwd / Rev" switch up to enable reverse, and put the "Rev Enable" switch up. The hopper moves backward about one-seventh of a

(Cont. overleaf)

Slot Tech Upcoming Event

Monitor Repair and More!

Slot Tech Magazine Announces Two-Week Technician School

As many of you are aware, Slot Tech Magazine offers a two-week technician training course called (for lack of a better term) the Casino School. It's kind of a "Super TechFest" where we have time to cover everything from basic electronics and troubleshooting to component-level monitor repair. Throw in a good mix of detailed training on coin acceptors, bill validators, ticket printers and touchscreens and you sort of get the idea. Add the "hands-on" training that is impossible at a three-day TechFest and you have a program can really boost the skills of a beginning to intermediate level slot tech.

Normally, a casino that wants this type of training will reserve a class exclusively for their own technicians. We bring the training right to the casino. The class size is small for the two-week class. In fact, it's limited to just 16 people. But even that number of folks can be tough for a single casino to spare for two full weeks.

In order to make this training available to more slot techs, Chip In's Island Resort in Harris, Michigan has offered to sponsor the program and allow technicians from other casinos to join them for the two-week class.

So, the program is set and we're on for Slot Tech Magazine's Casino School. To reserve your place in the class at Chip In's Island Resort and Casino in Harris, Michigan (September 13-24) please go to the website at slot-tech.com, download and return the enrollment form along with your tuition of $1295.00.

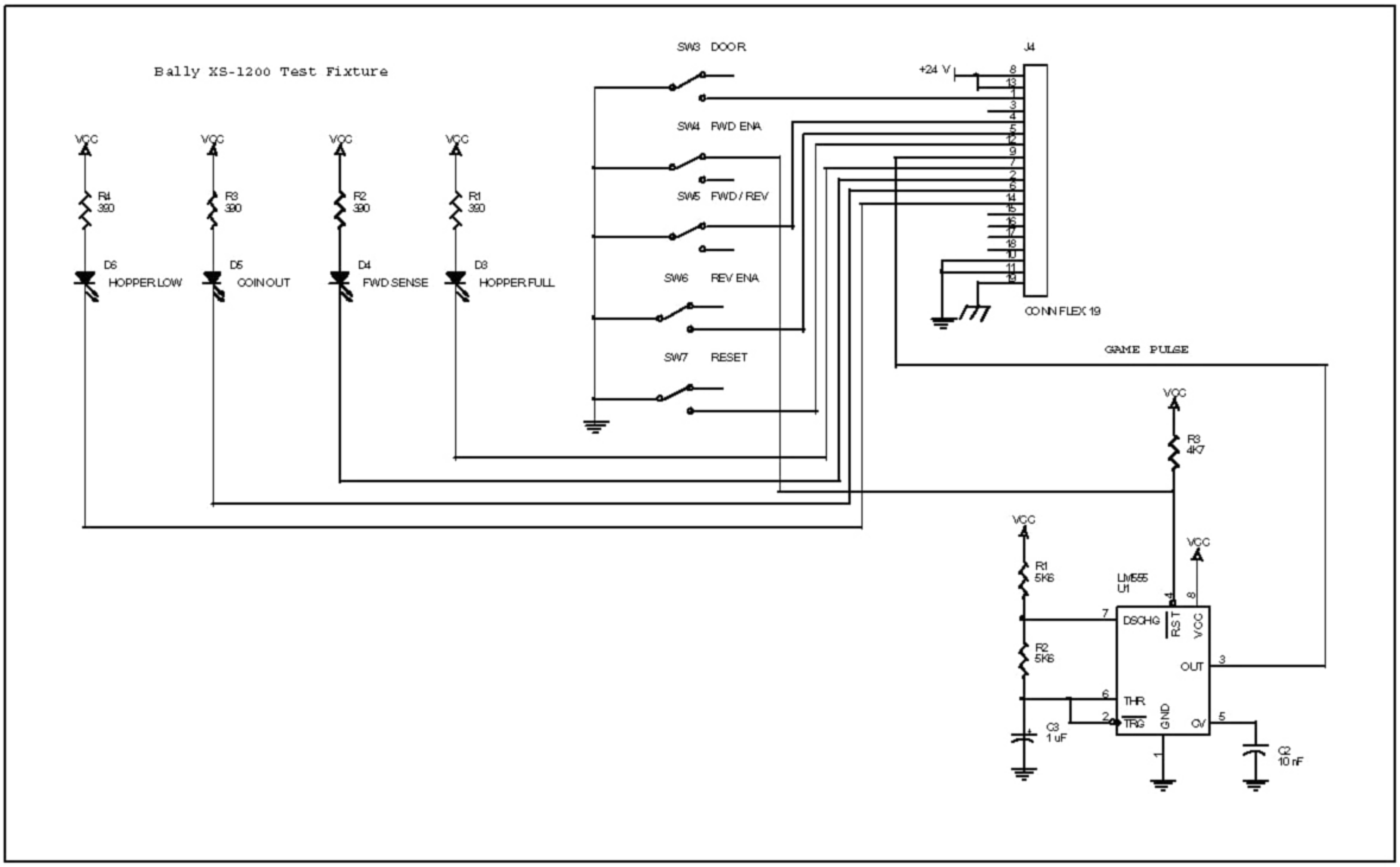
As the class size is exceedingly small, reservations for the class are strictly on a "first-come, first-served" basis. When we receive your tuition, you're in. Purchase orders are welcome and will be invoiced but placement is not guaranteed until tuition is in hand.

For more information and an enrollment form, please visit the website at slot-tech.com or give us a call at Slot Tech Magazine, 619.593.6131.

See you at the Casino School!

Randy Fromm

Randy Fromm



revolution, stops, backs up another step, stops, and continues until the switches are put in the Down position. To go Forward you put the "Fwd Enable" switch up, the string of 100 Hz pulses begins, and the hopper runs forward, as does the Mixer if you have one on your hopper. Typical current on a hopper with no load is about 300mA to 400 mA. When the hopper gets a jam it pegs my power supply at about 2 Amps.

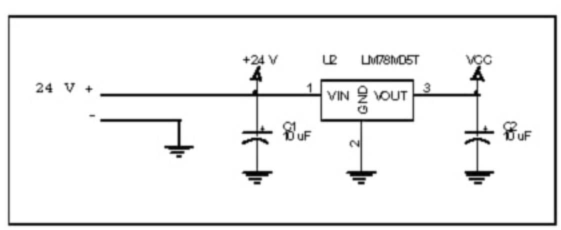
While going forward feeding coins, you should see the "Coin Out" LED blink on every outgoing coin. Remember the XS-1200's microcontroller is in between the optics the the output.

If you stick something up the coin out chute and block the optics the hopper should stop, the Coin Out LED should go out and stay out. Reset should be required before you can go forward again.

To use the buttons on the XS-1200 Hopper Control Board you have to give the board a "Door Open" indication. It should seem obvious that you have to open the door to push these buttons. These buttons are only enabled if the main game door is closed. In order to do Reverse manually the "Reverse Enable" switch must be up. Holding the Forward switch down should run the hopper forward. Holding the Reverse switch down should run the hopper in reverse continually. Holding both switches down should run the Mixer motor if you have one.

On the circuit board we have the 5 Volt regulator and its capacitors, four resistors for the LEDs and our 100 Hz oscillator. They all fit with room to spare.

If you use a different power supply for the 24 volt supply it should be capable of supplying about 2 Amps and be regulated and filtered.



Troubleshooting

If operation is not normal and we can not get the hopper motor to go forward or reverse by the buttons or the test fixture switches we need to resolve if the problem is in the control circuits going to the PIC16, is it in the PIC16 itself, or is it in the motor control circuits. Turn off power. Pull out the PIC16. Restore power and see if we get signals out of U3 pins 6, 8 and 11 as we push the buttons on the Hopper Control Board or manipulate these inputs from the Test fixture.

If the problem is not in the control circuit we may next consider the motor driver circuits. With the PIC16 out of the circuit pulling U1 pin 17 (the PIC16) Low we should make the hopper run in reverse. Pulling U1 pin 18 low should make the hopper run forward. The Run line should float High, enabling the motor circuits.

If both of these check okay replace the PIC16 with the proper kind for the model of XS-1200 you have. Not all are the same. The -0368 board uses p/n E-01056-0018 or -0017. The -0339 board uses p/n E-01056-0014, or -0007 or -0008. The firmware is different between the two. Other versions of the board may use different firmware and have a different part number on the microcontroller.

Feed coins from the hopper and see that the Coin-Out LED blinks as each coin exits. Block the optics and see that it detects a blockage. Physically jam the hopper and see that it properly detects a jam. The hopper should stop and back up a bit before going forward again. If you have one with a Mixer, hold the mixer cage and see that it properly detects a stall.

After a Jam condition the Hopper Control Board will have to be cleared. Do this a couple of times and clear the condition with the Door Switch as well as Reset line.

See that the pushbuttons can not be used if the Door is closed.

A short lesson in troubleshooting microcontroller based circuits

The circuit from the backplane to the hopper connector is in the prints of the overall game, and is included in a drawing here. Not apparent in the prints is the wiring between the hopper connector and the hopper control board. That also is shown here.

If some function does not work all you have to do is identify the parts of the circuit that are involved with that function. Since the hopper control board is microcontroller based we can split our troubleshooting up at the microcontroller. The game does not drive the hopper motors or sense the optics directly. All functions except the Hopper Level probe go through the microcontroller; so we can ask ourselves "Is the problem a communications problem between the microcontroller and the game, or between the microcontroller and the hopper circuits?"

For an example, if our hopper does not go forward on commands from the test box we may ask ourselves, "Is the microcontroller getting the command to go forward?", "Is the microcontroller giving the proper outputs to drive the motors?", and "Is there some other problem (Reset or Power) that gives a condition preventing us from operating?"

If the Fwd Enable pulses are getting to the microcontroller, reset is high and power is okay, we have the advantage of a simple circuit. we can pull out the microcontroller that is on a socket and jumper the circuits to a proper level manually, confirming that the motor drive circuits are good. This narrows the problem down to the microcontroller (bad or wrong version).

If our problem is Coin Out not happening we can again break the circuit up at the microcontroller. removing the microcontroller we can manually manipulate the voltage going to the Coin Out driving transistor and confirm that circuit works. We can Enable the Coin Out Sensors, wave something through the optics and confirm that the optics are working.

If the optics are working and the Coin Out driver transistor is working but we do not have Coin Out under normal operation we have again narrowed the problem down to the microcontroller.

We do not have to completely understand the firmware inside the microcontroller, just realize what functions must take place for the hopper to work.

Problem history

Motor Drivers fail with obvious smoke and low resistance checks. Different boards use different motor drivers. It seems that as soon as Bally redesigned the board the part they used would go obsolete.

The PIC16 have a notable failure rate. I suspect that it is as much the fault of Slot Techs trying to swap them out without using safe static practices or even putting the chips in backwards. Since this the only socketed IC it is open to "Technician Misadventure", shall we say.

To cover other things in the "TM" category, I have also found jumpers in wrong or missing, wires pulled out of connectors and Coin Sensors connected wrong. Check the simple stuff first. Of the dozen or so I have had the opportunity to troubleshoot, only four were actually bad and "TM" may well have been a factor in all cases. That isn't a bad score. We have some pretty good techs but our new ones have a bit of a learning curve.

Other notes

The -0339 version uses much the same circuitry we have described. The motor drivers are different but functions are the same. There are options for using either the PIC16 type microcontroller or the MC68HC05J2 microcontroller.

Herschel Peeler
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Puck Group to Compete at G2E

Celebrity chefs from acclaimed restaurants Circo, Le Cirque, NOBU, Olives, Summer Shack and the Wolfgang Puck Fine Dining Group will headline activities at the first F&B at G2E, a culinary marketplace catering to the burgeoning food and beverage sector of the gaming industry. Sponsored by the Epicurean Club of Las Vegas, F&B at G2E will be a unique event within Global Gaming Expo (G2E) encompassing exhibits, a dedicated conference track and special events, debuting Oct. 5-7 at the Las Vegas Convention Center.

"The breadth of activities and expertise available at F&B at G2E makes this the must-attend event for executives interested in strengthening this area of their business," said Frank J. Fahrenkopf, Jr., president and CEO of the American Gaming Association, which organizes G2E along with trade show partner Reed Exhibitions.

F&B at G2E will kick off G2E 2004 with the Neon Chefs, featuring two teams of Las Vegas chefs in a live competition modeled after The Food Network's Iron Chef series. The Oct. 5 event, organized by the Epicurean Club of Las Vegas, will pit David Robbins, executive chef and managing partner of Wolfgang Puck Fine Dining Group, and Peter Woo, executive chef at Hard Rock Hotel's NOBU Restaurant, against Marc Poidevin, executive chef at Bellagio's Le Cirque, and James Benson, executive chef at Bellagio's Circo. Television personality Robin Leach will serve as master of ceremonies for the event, and judges will include Chris Marcoux, a partner with Shonkwiler-Marcoux Agency and a former chef; Lincoln Spoor, Krispy Kreme Nevada franchise owner; and Muriel Stevens, Nevada food critic and writer for the Las Vegas Sun.

All F&B special events will take place in the dedicated F&B at G2E area of the G2E show floor. For more information or to register for G2E 2004 or exhibit at F&B at G2E, visit www.globalgamingexpo.com.

Above: Archive photograph (circa 1995) of Slot Tech Magazine publisher Randy Fromm and celebrity chef Wolfgang Puck.

Understanding Harmonic Suppression Systems

Get a Handle on Wasted Energy and Excess Heat

By Michael Lowenstein and Jonathan Piel

A typical casino will have thousands of switched-mode power supplies on-line, twenty-four hours a day, seven days a week, 365 days a year. A typical slot machine will have at least two and likely three or more. There's the SMPS for the monitor (regardless of whether it's a CRT or an LCD), the power supply for the game's logic and often a separate power supply for the bill validator. Possibly added to the mix will be a power supply for a hopper, ticket printer and/or SMIB.

Multiply that by 2000 machines or more, add in all of the computers for the back-end system (including all of the DCUs, etc.) as well as each and every office computer and its associated monitor along with the display monitors scattered around the casino floor, in the surveillance room and, if you have a hotel, all of the television sets in the guest rooms and you begin to see that your casino has thousands of switched-mode power supplies in operation at this very moment.

"So what's the big deal about that?" you ask. "As long as the power company can provide enough current to power the machines and we have the place wired properly so the current is distributed and the loads are balanced correctly, it's all good, right?"

Well, yes and no. Sure, it all works correctly but there are hidden, insidious forces at work when you have so many switched-mode power supplies in operation at the same time. These evil forces are dropping the efficiency of your system and likely causing you to spend thousands of extra dollars each year, not only for electric power but also for the air-conditioning required to cool your casino.

These nefarious culprits are called "harmonic currents" and it's up to the White Knights of technology to eliminate them from your gaming property forever. Problems caused by harmonic currents include overheated transformers and wiring, random circuit breaker tripping and reduced useable system capacity.

Our White Knight is something called "harmonic suppression." Harmonic suppression systems can be installed to eliminate the flow of the

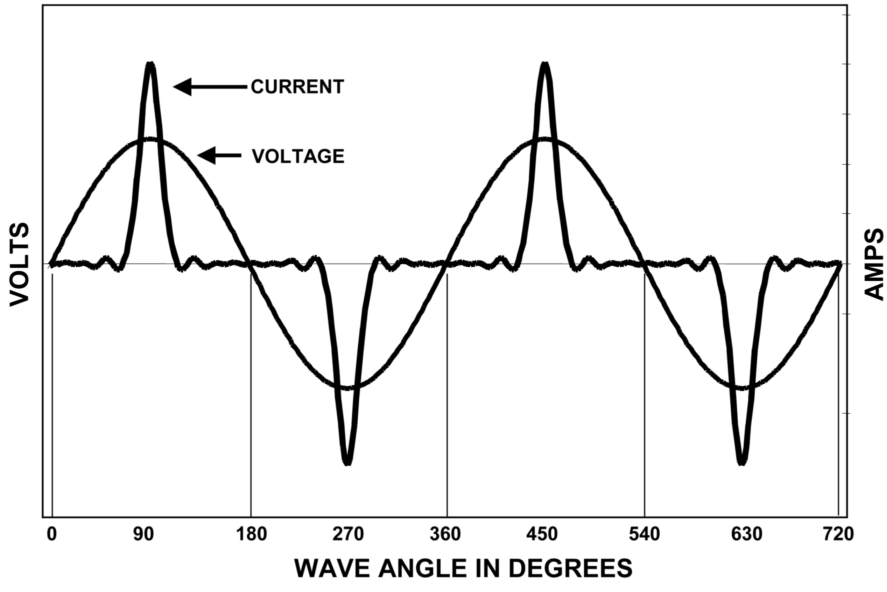
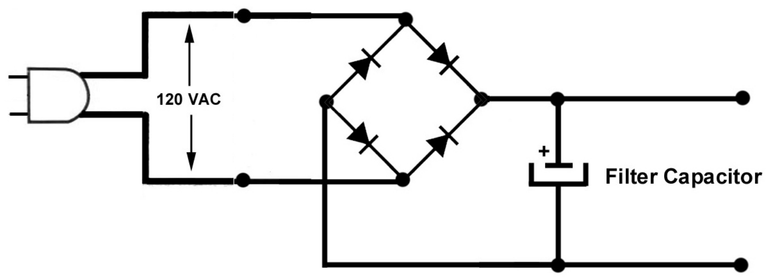


Figure 1. Here's our first problem: Although the AC voltage is a sine wave, the rectifier draws its current in spikes.

most troublesome of these bad boys, the "third harmonic" currents. Economic benefits of installing such systems include increased capacity (good if you’re in California where Governor Arnold Schwarzenegger has just signed an agreement allowing unlimited slot machines) increased component lifetime and reduced down time. Later in this discussion, you’ll see how it is now possible to measure the energy savings obtained when excessive harmonic current flow is eliminated in an electrical system. These savings are due to reduced I^2R losses in transformers and wiring and reduced air conditioning costs.

Harmonic Currents

Harmonic currents are a direct result of the way in which a switched-mode power supply (SMPS) draws current from the system. The input circuit of an SMPS is a bridge rectifier that changes the 120 volt AC input to DC. A capacitor smoothes this DC to eliminate voltage ripples and the resultant DC bus has a voltage of about 170 volts when the AC rms input is 120 volts. Although the AC voltage is a sine wave, the rectifier draws its current in spikes as shown in Figure 1. These spikes require that the AC supply system provide harmonic currents, primarily 3rd, 5th and 7th. These harmonic currents do not provide power to the SMPS, but they do take up distribution system capacity. The principal harmonic current is the 3rd (180 Hz) and the amplitude of this current can be equal to or even greater than that of the fundamental current.



The input circuit of an SMPS is a bridge rectifier that changes the 120 volt AC input to DC. A capacitor smoothes this DC to eliminate voltage ripples and the resultant DC bus has a voltage of about 170 volts.

Harmonic Current Flow in a Wye Distribution System

When SMPS loads are connected as shown in Figure 2, each phase wire carries both the 60Hz fundamental current that supplies power to the SMPS and the harmonic currents that are there because of the way the SMPS draws its current. While most

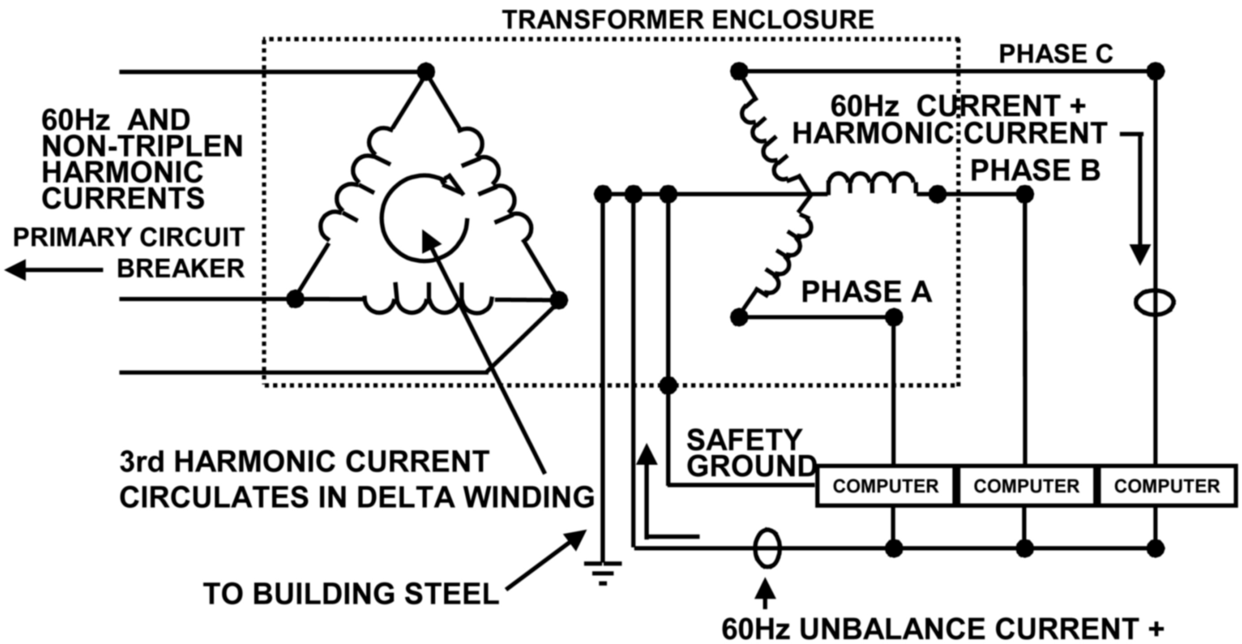


Figure 2. 208/120 Wye distribution system with phase-neutral computer loads

of the harmonic currents cancel in the neutral wire, just as the 60Hz currents do, the 3rd harmonic current and other currents divisible by three are additive in the neutral wire. Thus, if the 3rd harmonic current were 100 amps in each phase, the 3rd harmonic current returned to the X0 transformer connection by the common neutral wire would be 300 amps.

This fact has implications for system design, since the entire electrical system must meet the national electrical code specifications for wire and conduit size. If it is expected that SMPS loads will cause high neutral currents, wires must be sized for the anticipated load. Instead of downsizing neutral wires, once common practice for a system supporting only linear loads, now neutral wires must be oversized or doubled. Larger conduit must be installed to handle more or larger wires. (Although the code permits downsized neutrals if the system is not powering non-linear loads, language in NEC 310. 15(B)(4)(b, c) (2002) requires neutral conductors to be considered current-carrying conductors when nonlinear (SMPS) loads are present. It should be noted that there is no code requirement for double neutrals, only that the neutrals be properly sized for the expected current.)

System Problems Caused by 3rd Harmonic Currents

The effect of current distortion on distribution systems can be serious, primarily due to the increased current flowing throughout the system. Following are some of the problems that must be considered.

1. All distribution systems are rms current limited. For instance, a 150 kVA 208/120 wye transformer is rated for 416 rms amps per phase. The more harmonic current flowing, the less fundamental current can be supplied. Since the harmonic current does not deliver any power, its presence uses up system capacity and reduces the number of loads that can be powered. Either the system must be de-rated or a larger system, that can only be partially utilized, must be installed.

2. Harmonic currents flowing through the system wiring cause increased I^2R heat losses. This heating can increase the temperature of wires and switchgear to the point that erratic operation or even fires can occur. One study found that 33% of telecommunication fires were

caused by failures of power systems or components.

3. Balanced 3rd harmonic currents cannot flow out of a delta primary. Therefore, they circulate in the primary of the transformer where they are dissipated as heat, Fig. 2. The current circulating in the transformer delta primary winding contributes to the load on the winding, but does not flow through the primary circuit breaker protection. Thus the transformer primary winding can be overloaded and the breaker that is expected to protect the transformer will not do so.

4. Heat dissipated by transformers, switchgear, and wiring represents wasted energy. Energy losses, brought about by harmonic current flow, can result in significant increases in operating costs.

Alternatives for Harmonic Mitigation

Accommodation Methods

Traditional methods used to mitigate the effects of harmonic currents involve "accommodation" of the currents after they are in the system.

1. Overbuild the system to handle the extra current. Double-sized neutral wires, oversized switchgear, and transformers de-rated to less than their full capacity are examples of system overbuilding.

2. Install a k-rated transformer. To reduce the chance of transformer failure due to overheating, special transformers, known as "k-rated," have been designed to handle high harmonic loading, including 3rd harmonic currents circulating in the delta primary. The k-rated transformer will survive overheating when subjected to high harmonic loading, but the harmonic currents are still present in the system.

3. Install a zig-zag reactor. The zig-zag reactor contains special windings connected so as to present a low impedance to 3rd harmonic currents and a high impedance to 60 Hz currents. When a zig-zag reactor is connected between the phases and neutral of a wye system, the 3rd harmonic currents are diverted through the device. These currents no longer flow, from the point where the zig-zag is connected in the system, upstream to the transformer. However, the phase and neutral wires from the zig-zag toward the loads still carry all the harmonic currents including the 3rd, and double neutral wires are recommended.

4. Install a zig-zag transformer. A "zig-zag" transformer can be used to replace the standard transformer in a system. This device has the special windings of the zig-zag reactor built into the transformer secondary so that the 3rd harmonic currents are cancelled in the secondary and do not circulate in the primary winding. Again, the phase and neutral wires from the transformer to the loads still carry all the harmonic currents and double neutral wires are recommended.

Problems with Accommodation Methods

While accommodation methods enable the electrical system to survive harmonic currents, they have a number of shortcomings.

1. Useful system capacity is not changed. Harmonic currents still flow throughout the system wiring and rms current is not decreased.

2. Heating of wires and switchgear is not reduced. Although the temperature of transformers may be reduced, harmonic currents still flow throughout the system wiring.

3. Energy losses due to I^2R heating are not reduced. Since the harmonic currents still flow throughout the system wiring, energy is still wasted. In fact, studies have shown that the installation of certain accommodation methods may actually increase energy losses. The typical impedance of zig-zag transformers and k-rated transformers is lower than that of a standard transformer. Likewise, an oversized transformer typically shows a lower impedance than a smaller transformer. Since transformer impedance is lower, harmonic current flow throughout the system is actually increased. A recent study shows that a signifi-

Transformer	% Impedance	kW Change (45 feet)	kW Change (145 feet)
Standard	**5.6%**	**Baseline**	**Baseline**
K13	**3.6%**	**+ 1.51%**	**+ 2.46%**
Zig Zag	**3.6%**	**+ 2.27%**	**+ 4.37%**

Table 1. Increase in kW useage due to decrease in transformer impedance

cant increase in kW usage results from installing a lower impedance transformer. Data from this study are shown in Table 1.

Harmonic Suppression

Harmonic suppression systems (referred to as HSS) use a different approach to mitigate harmonic currents in the distribution system. Their application is based on the same concept that is used in modern medicine, "preventative action. "Instead of treating the symptoms of a disease, it is far better to keep the disease from occurring. The HSS is designed to prevent the flow of harmonic currents in the distribution system, rather than treating or accommodating the currents after they are there.

The HSS consists of a parallel resistive/inductive/capacitive (RLC) network tuned to the 3rd harmonic, or 180 Hz for a 60 Hz fundamental frequency. The electrical characteristics of this type of circuit are such that it has a very high resistance to the flow of 3rd harmonic current and a very low resistance to the flow of the fundamental 60Hz current. Application of the HSS is shown in Figure 3.

The HSS is connected between the neutral wire and the transformer X0. All current that flows through the phase wires to the load must return through the neutral. If 3rd harmonic current cannot flow in the neutral, due to the high impedance of the HSS, then no 3rd harmonic current can flow in the phase wires. The damaging 3rd harmonic current is blocked throughout the entire distribution system from the transformer out to the furthest load. There is no 3rd harmonic current circulating in the delta transformer primary because there is no 3rd harmonic current available to circulate. The transformer is now fully protected by the primary circuit breaker against overloading. Phase

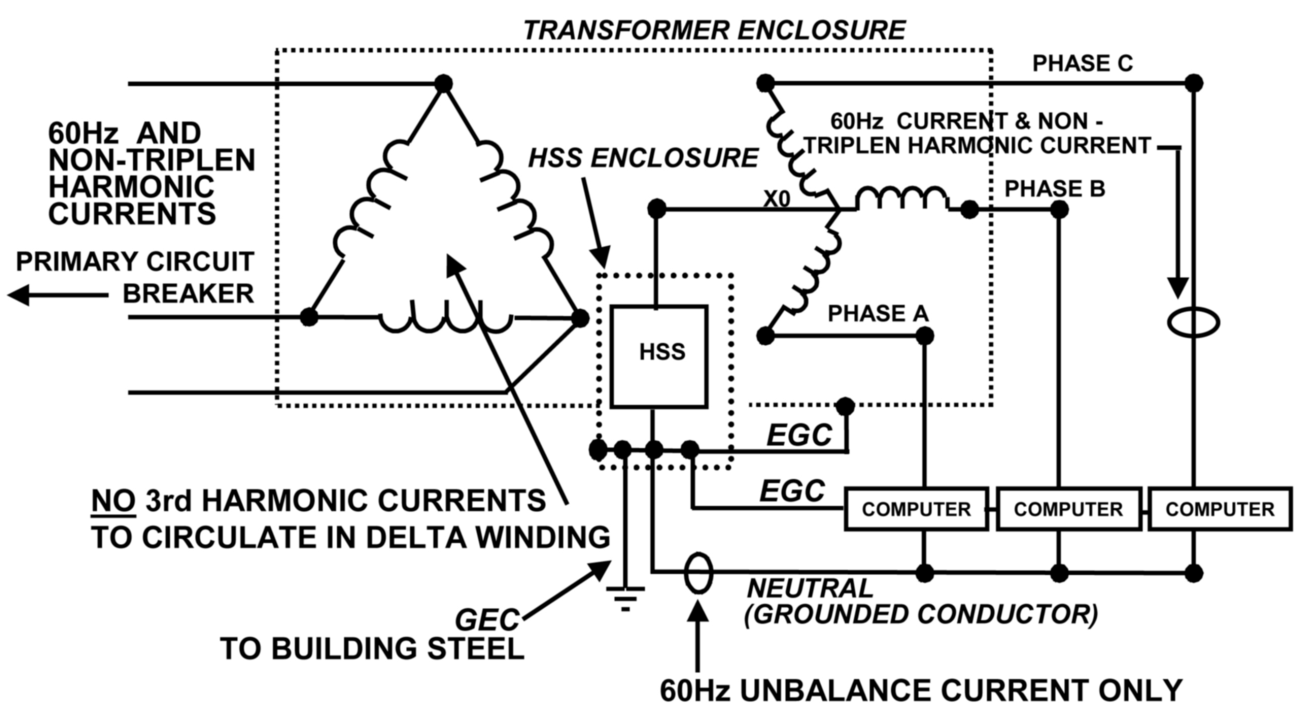


Figure 3. 208/120 Wye distribution system with phase-neutral loads and HSS

I^2R energy loss in transformers and wire due to harmonics:

Transformers:	Quantity:		
		60%	Average transformer loading
15kVA		**90**	**Total kW load**
30kVA		Note: kVA ~ Total kW = kW(operating) + kW(I^2R harmonic current losses)	
45kVA			
75kVA		100%	Percent of total kW load which is non-linear
112kVA		**90**	**Total kW of non-linear load**
150kVA	1		
200kVA		8760	Annual operating hours of non-linear load (24 hours x 7 days/week = 8760 annual hours)
225kVA			
300kVA		**788400**	**Annual kWH of non-linear load**
500kVA			
Total kVA:	**150**	$ 0.0850	kWH billing rate
		$ 67,014	**Annual cost of non-linear load operation without HL**
	x	6.5%	**kW savings due to reduction of I^2R harmonic current losses**
	=	$ 4,356	**Annual dollar savings based on % kW savings due to reduction of I^2R harmonic current losses.**

Figure 4a

wires have more capacity available to carry useful load and double neutrals are not necessary. The neutral, for code purposes, need no longer be considered a current carrying conductor. Overheating of transformers, switchgear, and wiring is eliminated, increasing the lifetime of all system components.

Benefits of the HSS

Four areas will be discussed: 1) enhanced life safety; 2) increased system capacity; 3) greater reliability; 4) energy and operating cost savings.

1) Enhanced Life Safety.
3rd harmonic currents flowing in the system can overload transformers, switchgear, and wiring. With neutral currents greater than the phase currents, facilities, and particularly older facilities, are at risk from overheated wiring leading to fires. Transformers with high 3rd

A typical installation

System air conditioning cost saving by eliminating harmonics:

			Summary	
	90	**Total kW of non-linear load**		
		kW savings due to reduction	**Annual savings due to**	
x	6.5%	of I^2R harmonic current losses	**reduction of harmonic**	
	5.9	**kW energy losses as heat**	**current losses:**	$ 4,356
x	3415	BTU/HR per kW		
	19978	BTU/HR		
/	12000	BTU/HR per ton A/C	**Annual savings due to**	
	1.7	**Tons of Air Conditioning**	**reduced need for heat removal**	$ 2,107
x	1.7	kW power usage per ton		
	2.8	**kW**		
x	8760	Hours of operation	**Total annual dollar savings:**	$ 6,463
	24792	kWH annual energy usage to	**Total 5 yr. dollar savings:**	$ 32,316
		remove harmonic heat	**Total 7 yr. dollar savings:**	$ 45,243
x	$ 0.0850	kWH billing rate	**Total 10 yr. dollar savings:**	$ 64,633
	$ 2,107	**Annual dollar savings due**		
		to reduced need for heat		
		removal		

Figure 4b

harmonic currents circulating in the primary, and unprotected against overloading, can fail or catch fire. By eliminating 3rd harmonic currents from the transformer to the furthest outlet, the HSS eliminates the risk of over-current caused fires.

2)Increased System Capacity.
All electrical distribution systems are rms current limited. Harmonic currents carried by transformers, switchgear, and wiring use up system capacity that could be used to carry 60Hz currents that do work. By eliminating 3rd harmonic currents throughout the entire distribution system, the HSS provides the facility with more useful capacity without requiring that the electrical system be upsized.

3) Greater Reliability.
The major cause of failure for transformers and switchgear is overheating. Random breaker tripping due to harmonic heating is well known. The elimination of 3rd harmonic currents reduces heat in all parts of the distribution system, thereby reducing the likelihood that system components will fail or trip off due to excessive temperatures. The elimination of high neutral currents lowers neutral-ground voltages and reduces the likelihood that data errors will occur.

4) Reduced Energy and Operating Costs.
Excessive heat in electrical distribution systems means wasted energy. The heat is due to I^2R losses in all system components, and appears directly in energy bills as increased kW hour charges. Installation of the HSS eliminates this wasted energy and leads to a direct reduction in energy costs. One recent study showed that, depending on transformer loading and the distribution distance from the transformer, the energy saved by eliminating 3rd harmonic currents ranged from a minimum of 2.5% to a maximum of 8% of the energy used to power computers. [3]Another study, conducted for the California Energy Commission, measured realized energy savings, due to the HSS, of from 4 to 6%. [4]

Energy Estimator

An energy savings estimator is available as a Microsoft

Excel spreadsheet as illustrated in Figures 4a and 4b on the next page. This estimator allows the user to input electrical system parameters for any system. The dollar savings expected for the system when an HSS is installed are quickly calculated.

In addition to the direct waste of energy caused by harmonic currents, there is a secondary effect. Air conditioners must be powered to remove this excess heat. Reducing extra operation of air conditioners, necessary because of harmonic generated heat, can add another 1-3% to the energy saved by an HSS.

Case Studies

Three case studies are outlined below. In each study, neutral 3rd harmonic currents were almost totally eliminated and useful load capacity was increased. It was estimated that energy savings due to the HSS would result in complete payback of the purchase cost in 14. 5 to 26 months.

Case study 1. A major TV broadcast studio

The following data were obtained for this facility:
1. 3-500 kVA UPSs
2. Neutral current reduced by 81% from 1513 to 283 amps
3. 3rd harmonic current reduced by 96% from 1508 to 56 amps
4. rms phase current reduced by 8%
5. Using energy savings estimator, ROI = 18 months

Case study 2. A major computer manufacturer

The following data were obtained for this facility:
1. 3-story office building
2. 225 kVA transformer 53% loaded
3. Neutral current reduced by78% from 301 to 67 amps
4. 3rd harmonic current reduced by 98% from 290 to 6 amps
5. rms phase current reduced by 12%
6. Using energy savings estimator, ROI = 26 months

Case study 3. An internet hosting facility

The following data were obtained for this facility:
1. 8-150 kVA k-13 transformers
2. Combined neutral current reduced by 76% from 1940 to 451 amps (average 56 amps)
3. 3rd harmonic current reduced by 98% from 1890 to 44 amps (average 5 amps)
4. rms phase current reduced by 21%
5. Using energy savings estimator, ROI = 14. 5 months

Conclusions

The harmonic suppression system is a well-established technology. As the case studies show, it has been embraced by a wide variety of users, including major computer manufacturers, banks, stock exchanges, educational institutions, insurance companies and broadcast facilities. In short, any group that uses multiple computers (such as a casino) can benefit from this technology. The capacity and energy savings are well documented and life safety and reliability issues also are addressed. The bottom line is that the installation of an HSS can pay for itself, by energy savings, in one to three years.

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Michael Z. Lowenstein holds an A. B. in chemistry from Oberlin College, and an MS and Ph. D. in physical and analytical chemistry and physics from Arizona State University. He spent 13 years as a College Chemistry Professor and 8 years as a National Program Manager for the Solar Energy Research Institute. His experience with harmonics includes 15 years designing filters for 3-phase industrial drives. In 1989 he founded Harmonics Limited, a company devoted to solving harmonic problems caused by multiple computer loads. He is currently President and Chief Technology Officer of the company.

Jonnathan K. Piel received a BSEE degree from Michigan Technological University. He is currently the Engineering Manager at Harmonics Limited, Milwaukee, Wisconsin, where he is responsible for power quality-related research, training, and product development. His main area of research has been single-phase non-linear harmonic phenomena and solution applications.

UNICUM

A big headline for a big company, Unicum is the gaming Goliath of Russia. With headquarters and manufacturing facilities in Saint Petersburg and offices in Moscow, Riga, Kiev and Ekaterinburg, Unicum currently provides gaming products and services to 80% of the market in Russia and the CIS. Unicum's customers include major Russian casinos, slot hall chains, entertainment complexes and over 2000 operating businesses.

The company employs 500 people. There are 350 at the headquarters in Saint Petersburg and 120 at the office in Moscow. The balance is distributed between the sales offices. Unicum (meaning "unique" according to Anastassia Kojemiakina, the company's highly efficient PR Manager) has been distributing slot machines and other casino equipment since 1990. In 2002, they began manufacturing slot machines, choosing to license products from some of the world's leading manufacturers. Machines from Atronic (Austria), Bally (USA), and Ainsworth (Australia) are now "born in Russia" in an assembly process that Unicum Material Manager Rozhkov Konstantin jokingly equates to "working with Legos."

The cabinet components and sub-assemblies for new machines are imported from the OEMs and from Italian cabinet

Above: A small piece of Unicum's Moscow showroom.

Right: Daria Kanevskaya is Unicum's Saint Petersburg office secretary. The office bird is called Kokosha. On Daria's desk is a photograph of Saint Petersburg's favorite son, Russian president Vladimir Putin, who was born in the city.

manufacturer Gevin (known as well for their amusement machine cabinets) while wire harnesses and other connector assemblies are manufactured in-house. In some machines, Unicum uses CRT based monitors from well-known manufacturers such as Kortek and Tatung. For other manufacturing runs, customized open-frame monitors are manufactured in-house by combining high-resolution desktop computer monitors with stamped and formed sheet metal frames that have been manufactured locally. All of the assembly is done in Saint Petersburg. There are plans to have additional cabinetry metalwork done by local Saint Petersburg sub-contractors as well. Pay glass and belly glass for the machines are also produced in-house.

“All our engineers are highly skilled specialists,” said Konstantin, gesturing toward the workers on the busy assembly line. The Saint Petersburg factory churns out 500 Atronic Cashline machines and 300 Bally Gamemakers per month. Ainsworth games are split between 200 Celebrity machines and 100 of their high-end Ambassador per month. In addition, 300 - 400 of Unicum’s own Adventure machines are produced per month. The Adventure series includes the hilarious African adventure game, Tam Tam.

Unicum Material Manager Rozhkov Konstantin

This fellow really gets into his work!

The machines are put together in large open assembly rooms, using more-or-less conventional manufacturing and assembly techniques. Several large and well-organized teams of quality-control inspectors examine every step of the manufacturing process and carefully tick off each procedure as noted on reams of quality-control documentation. Exacting standards are rigorously applied to each step of the process and if necessary, substandard items are immediately scheduled for rework.

In order to cut down on import costs and boost local employment, the company plans eventually to bring most of the cabinet manufacturing in-house or with local sub-contractors. At that point, they will license the software only.

Previously operated WMS 550 machines are literally “reborn” at Unicum as well. The machines are imported as used, then completely refurbished as necessary with new bill validators, wiring and cabinetry repairs. Unicum also distributes WMS’ latest product, the Bluebird platform, as reported last month in Slot Tech Magazine.

One of the assembly rooms at the Saint Petersburg factory.

Quality Control on the assembly line.

Consulting, Other Casino Equipment Offered

In addition to manufacturing and distributing slot machines, Unicum also offers professional consulting in products selection, disposition, business promotion and training. Spare parts and accessories are available through the company as well.

Unicum also supplies casino equipment to the Russian market through their partner relations with well-known British companies such as John Huxley, London Casino Supplies and Casino Equipment Warehouse. The company boasts that they will make shipment within three days of the receipt of the order. They also offer a wide variety of casino accessories such as plastic and semi-plastic playing cards, water-resistant table covers made from wear-resistant fabric, floats, balls, cutting cards and more.

Spare Parts and Accessories

Another of Unicum's new areas of activity is spare parts and accessories sales. The company offers spare parts for slot machines from Atronic and Bally.

"Keen interest towards the gaming business and eight years experience in spare parts for electronic and radio equipment sales has naturally drawn me to Unicum," said leading manager of the department of spare parts and accessories Maya Borovskih. "The combination of close relations with suppliers and my personal expertise always let my provide the best care for the customers, and execute your order quickly and completely."

Systems in Progress

The most profoundly important product from Unicum isn't a slot machine at all. It is a revolutionary new system for tracking machine performance and income as well as providing easy control over an almost unlimited variety of jackpots. It also provides an interface to other devices such as ticket printers and LED signage.

It's called "Systems in Progress" and although the name might seem to suggest that it's a work yet to be completed, it's actually a remarkable and unprecedented advance in slot machine "back end" systems. It does, in fact, flip things 180 degrees, moving the "back end" to the front of the network, where it arguably belongs. Systems in Progress completely eliminates the need for a computer room filled with DCUs and their associated switches and hubs and the myriad of the other rack-mounted mystery devices with tiny blinking lights on them.

Making harnesses in the clean and sunny upper floor of the St. Petersburg factory.

Like other casino management and real-time monitoring systems, Systems in Progress (hereafter referred to, on occasion, as SIP) provides the operator with machine statistics. The system makes sure that all results correspond to events and that the amount shown on a meter corresponds to the actual amount. The system reports all of the accounting data for each machine as well as error reporting.

The system also provides real-time reporting of the gaming process. The operator is able to react immediately to events such as a jackpot hit, an unusual increase or decrease in gaming activity - either throughout the entire venue or in some of its zones - unusually heated playing, etc.

The SIP provides comprehensive gaming machine statistics, allowing the operator to determine the optimum placement and range of gaming machines, games, and credits for a gaming site.

So What Makes SIP So Different?

With its roots firmly implanted in the rich topsoil of the latest in computer hardware and networking technology, Systems in Progress is a completely new paradigm in slot machine networks, at once embracing Distributed Computing, Flash Memory, and TCP/IP (all proven technologies that we use every day) to create a quick, easy and cost-effective slot system.

Revolutionary System Architecture

A typical slot system is an impressive array of servers, DCUs, controllers and hubs. Typically, all of these elements are located in a large air-conditioned room. Generally speaking, there is a human being whose full-time job is maintaining and operating the system.

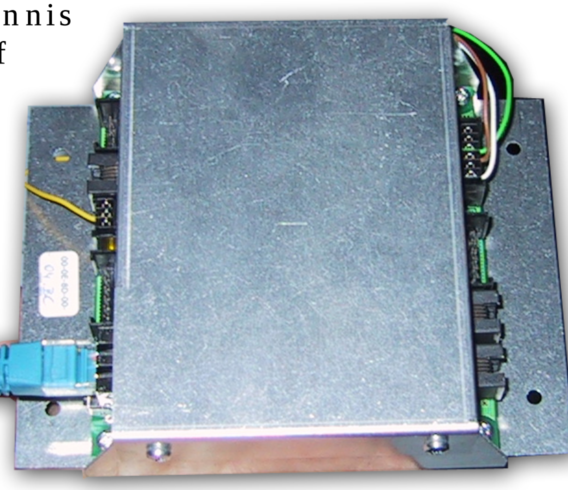
Dennis Sudakov, head of Unicum's SIP project

Systems in Progress eliminates all of that through the use of a smart SMIB. There is one SMIB located inside each machine. Not your ordinary SMIB, content to simply translate voltage levels and protocols, this intelligent device is a microcomputer onto itself, complete with non-volatile Flash Memory and network interface.

"All of the software plays in the SMIB," said Dennis Sudakov, head of Unicum's SIP project. "The SMIB is manufactured in Austria to Unicum's design."

Because this is an embedded computer that uses flash memory, up to three year's worth of book keeping data can be stored in its non-volatile memory where it will remain, regardless of power outages or even machine storage for extended periods of time.

No data is lost if a machine breaks down and there is no single point of failure. SIP's revolutionary approach to data storage using flash memory means a machine that is down will not affect the rest of the sys-


The SMIB

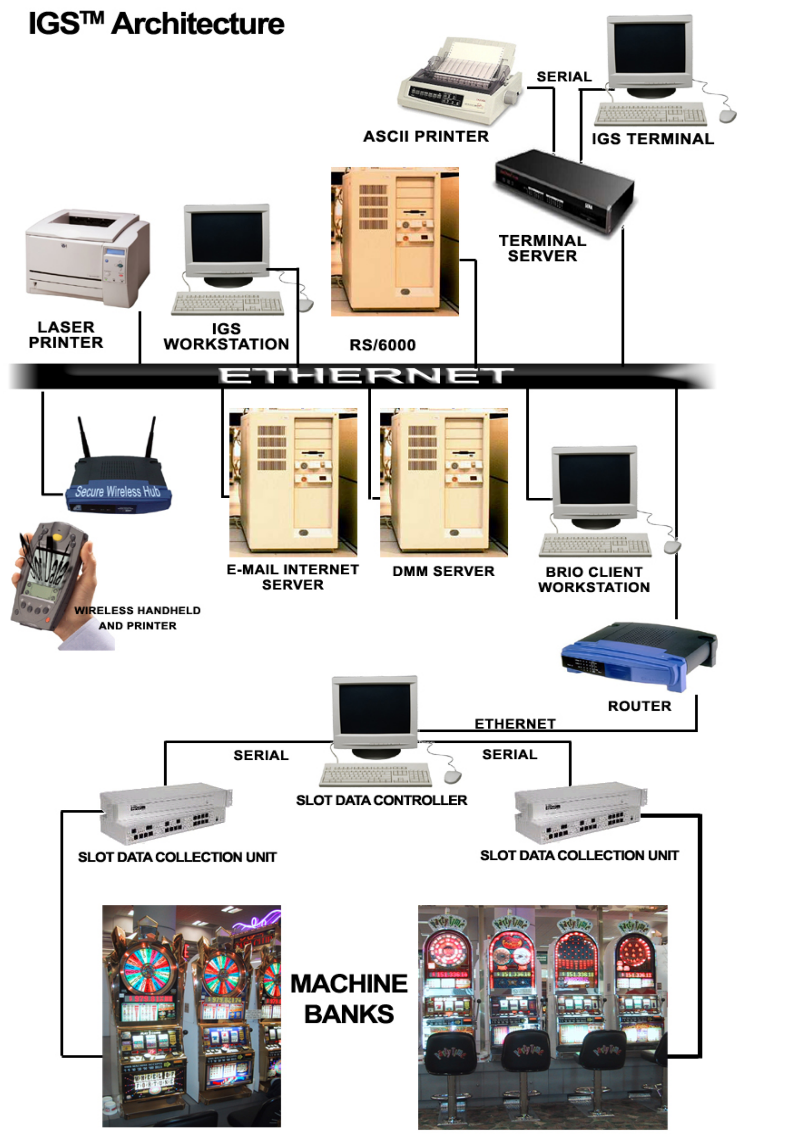
tem. Additionally, multiple storage of data from each individual machine ensures maximum data integrity.

The SMIB interfaces to any slot machine, utilizing the machine's internal power supply. Network interface is standard 100 Mps Ethernet using TCP/IP.

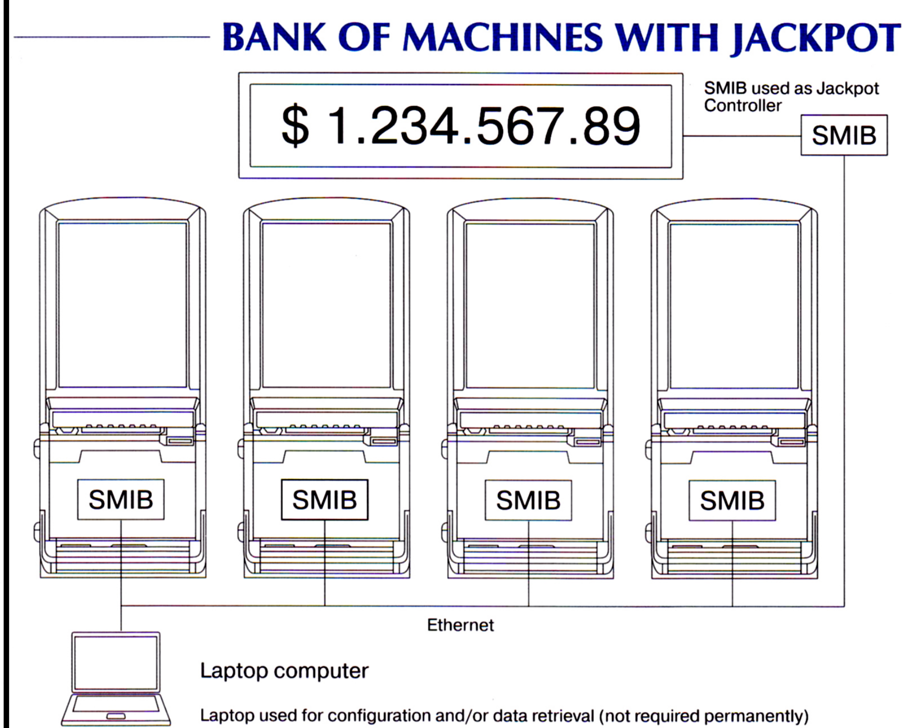
"We can convert any type of machine, running SAS or GRIPS or anything," continued Sudakov.

For your client software, all you need to access the system is Microsoft Internet Explorer. Naturally, passwords, encryption and all other safeguards are in place to prevent unauthorized access. Using a standard web browser allows slot operators to enjoy working with a user-friendly system featuring a familiar and intuitive interface that can be customized with minimal expenditure. No additional proprietary client software is necessary so there's no need to learn another program. New users can enjoy immediate productivity with a very steep learning curve.

Scalability and modular design allow the SIP system to be readily extended with additional features. The system is easily configured in accordance with the local business environment: currency, time zone, and other settings. Multi-lingual support is planned to be available in the near future.



(Above) A typical slot system compared to Systems in Progress (below).



Painless Installation and Configuration

When first connected, the system automatically detects and sets the Electronic Gaming Device (EGD) protocol. The protocol is used for communication between a machine and the SIP system. All major protocols are supported. Machine parameters (currency, denominations, max bet, theoretical payout percentage, game ID, pay table ID, etc.) are automatically retrieved by the system. It's all just "Plug 'n' Play."

The installation of hardware into gaming machines and connection to the network is typically carried out by the customer's slot technicians with technical assistance from SIP or, if desired, entirely by SIP system engineers. The old system is replaced smoothly and gradually. If required, both the old and new systems can be run concurrently. The new system is tested by creating key reports, which ensure that the information received from the old and new systems is identical.

Integrated Diagnostic Tools

This sophisticated feature detects and analyzes deficiencies in the system or the gaming machine. Protocol diagnostics track and log the protocol communication flow and highlight any communication errors. Meter diagnostics detect and report meter jumps, eliminating the need for time-consuming error identification. Naturally, there is a printout option that offers detailed reports.

The company also offers encrypted wireless support. Handheld devices increase the flexibility and productivity of floor attendants and technical staff by equipping them with PDAs for use in:

* **Installation.** Position IDs and configuration parameters such as brand and model can be easily assigned.

* **Diagnostics tasks**
Information such as the EGD protocol used or system status can be obtained and EGD and system parameters can be checked without any extra effort.

* **Hand payments**
Provide unparalleled customer service with speedy processing of wins and immediate printing of receipts at the machine. A list of all pending wins of the floor and constant documenting of transactions ensures maximum transparency of hand payment transactions.

There are plans as well for a novel "relocation" feature that allows an operator to relocate a slot machine to a different slot base and have its physical location within the casino automatically re-mapped and updated by the system.

Reporting

Systems in Progress shines brightly in the reporting arena, illuminating data that might otherwise go hidden in the dark corners of a database. Operators can keep on top of all relevant statistics using standard reports. Short, medium or long-term reports are available for up to three years.

A revenue report provides both an overview and a full report of all meter readings relevant to the win: total drop (Bill in & Coin to drop box); and total payments (Jackpots & Hand payments), including amounts at beginning and end of the period audited.

The bill count report displays the amount in bills counted per machine and per bill denomination.

The total handpay report tells you where and when handpays were generated on a specific gaming day as well as the origin of each handpay and its amount and status.

A pending handpay report displays a list of all attendant payments that still need to be processed.

The jackpot history summarizes jackpot information: current value, contribution for the period, start-up value, and the number and amount of jackpot hits.

Configuration reports provide details on system configuration, users, jackpots, etc.

Unparalleled Range of Jackpots

Systems in Progress' innovative and versatile bonusing concept has an unparalleled range of jackpot types and flexible configurations such as:

Progressives-the Classics among Jackpots

Linked progressive. This cash jackpot is awarded when a specified winning combination is reached on any participating machine.

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Mystery Jackpots - Limited Only by Your Imagination!

Standard mystery. A win can be any amount between a predefined minimum and maximum value.

Time limited cash mystery. A standard mystery jackpot, valid for a specific period of time and for certain times during the week.

Occupancy cash mystery. This jackpot is activated once a certain number of machines linked to this jackpot are in use.

Time limited occupancy cash mystery. A combination of time limited cash mystery and occupancy cash mystery; the start time, end time and occupancy rate can be defined by the operator.

Minimum bet mystery. Only players who place the set minimum bet for a game can win this jackpot.

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The Best Laid Plans - Part 2

The Big, The Bad and the Bonus

By John Wilson

After a long weekend of hard work, you're finally ready for the big meeting with all of the brass in upper management. They expect a full review of the new bonus game that will be implemented in your Blazin' 7s spinning-reel slot game. Although it was a lot of work, you have come up with some fantastic numbers for the game. Working with your counterpart in the Bonus Game Development Department, Larry, you have a solid overview of the new bonus game, including complete probabilities and payouts for the bonus game and a complete overview of how it affects the base game.

The meeting starts off very well. All of the V.P.s are there - Game Development, Marketing, Finance, even the BIG BOSS from the head office! They sit and listen to your presentation. All the time, you have neither inclination nor warning of what's about to happen! (eerie organ music plays)

You begin your presentation with Larry supporting your numbers and waiting for his turn to talk about the bonus game.

"The Blazin' 7s spinning reel slot game has been a very well-received game that promises us a large market share and increased revenue. The bonus game, which I'm told will be called Max Millions™, is going to revolutionize casino floors around the country and even way up in Canada, too. "

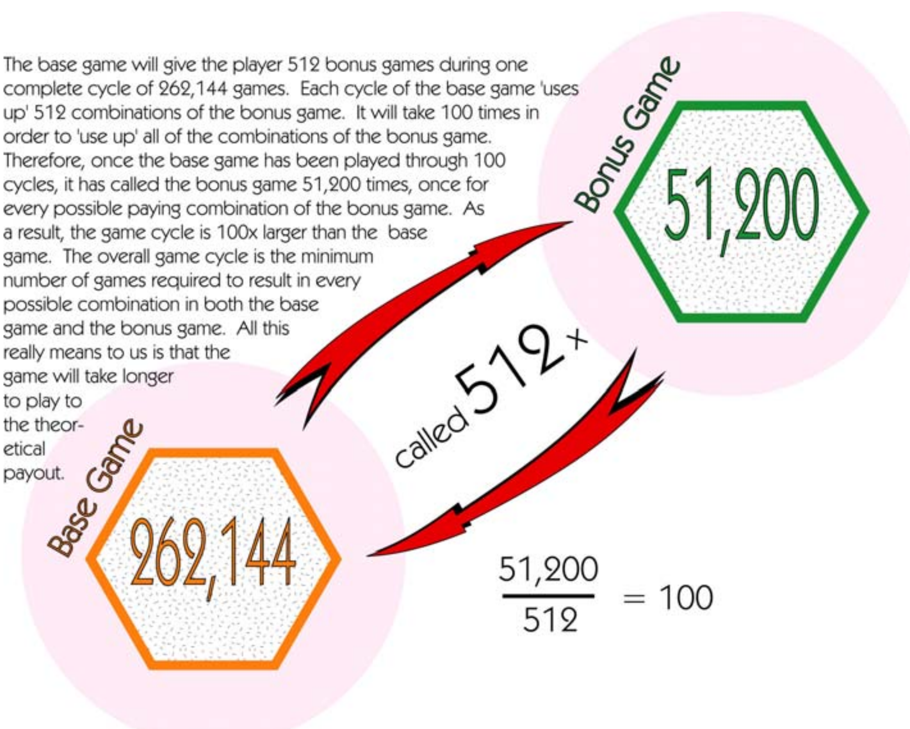
The integration of a bonus game creates a number of obstacles for the developers, namely:

- maintaining a high hit-frequency and payout percentage
- initiating the bonus game frequently enough to maintain player interest
- pay enough from the bonus game to keep players waiting for the next game
- make the minimum payout large enough and the bonus game frequent enough that the players don't become discouraged (e.g.: don't make the player wait through 45 minutes of play only to win 5 credits in the bonus game)
- keep the base game and bonus game payouts reasonable so that the player doesn't get most of his or her payout in the bonus game, and suddenly receive very few wins in the base game
- retain the original theme & play of the base game

It is also important to understand the basic premise of a bonus game, which details Wilson's law of bonusing. First, all of the payments from the bonus game must come from the base game. For each payment coming from the bonus game, a corresponding payment must be removed from the base game. This is similar to a progressive game. We could call this the 'Law of Conservation of Winning.' Winnings can neither be created nor destroyed. They must be transferred from one module to another.

Secondly, the bonus game will increase the overall cycle of the base game. Let's take a base game with a cycle of 262,144 games. Now, introduce a bonus game. Perhaps the bonus game is called 512 times during a complete base-game cycle. The number of times that the bonus game is called from the base game dur-

The base game will give the player 512 bonus games during one complete cycle of 262,144 games. Each cycle of the base game 'uses up' 512 combinations of the bonus game. It will take 100 times in order to 'use up' all of the combinations of the bonus game. Therefore, once the base game has been played through 100 cycles, it has called the bonus game 51,200 times, once for every possible paying combination of the bonus game. As a result, the game cycle is 100x larger than the base game. The overall game cycle is the minimum number of games required to result in every possible combination in both the base game and the bonus game. All this really means to us is that the game will take longer to play to the theoretical payout.



$$\frac{51{,}200}{512} = 100$$

is called from the base game during one cycle has no direct bearing on the cycle of the bonus game. The bonus game will likely have more than 512 paying combinations, however. This is acceptable as the bonus game has its own cycle. What you do, is multiply the base cycle and the bonus cycle together and divide by the number of times the base game calls the bonus game in its cycle, to get the overall game cycle. In the case of a base game with 262,144 game cycle and a bonus game with 51,200 cycle, the overall game cycle is 262144 * 51200 / 512 = 26,214,400.

Looking at this from a different angle, consider the 262,144 cycle calling the bonus game 512 times. The bonus game has 51,200 combinations. For each cycle of the base game, 512 options of the bonus game are used up. 51,200 / 512 = 100. That means that the base game will have to go through its cycle 100 times in order to make 512 * 100 = 51,200 every possible combination of the bonus game pay out. Therefore, the overall game cycle is 100 x larger than the base game cycle.

Starting the Bonus Game

There are a number of methods by which the bonus game can be initiated. We have decided that a special bonus-round symbol will be placed on each reel of the base game. The bonus game starts when three bonus-round symbols land on or within one position of the payline.

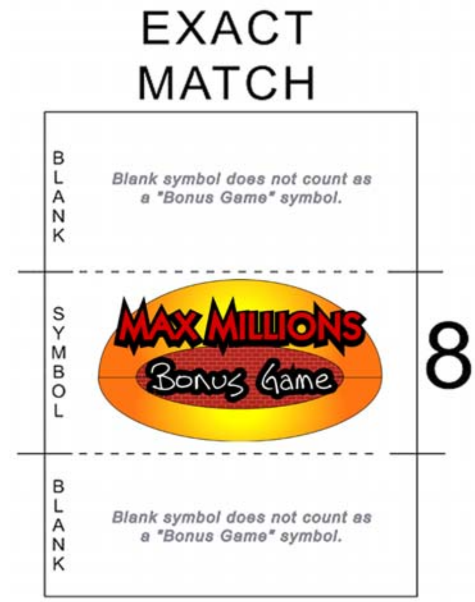
Having only one symbol on one reel would result in the bonus game being initiated too frequently. If we have a 64-stop game, then the bonus-symbol will come up once every 64 games, on average. It is the 1,000,000 credit award from the bonus game that requires us to initiate the bonus game less frequently. However, having three symbols on three reels could mean that the bonus game occurs too infrequently. On the same 64-stop game, having one bonus symbol on each reel means that the bonus game starts every 262,144 games. That's like hitting the jackpot on your average slot game. Nobody is going to wait around for that to happen!

We then looked at having eight stops on each reel. That gives us 8 x 8 x 8 or 512 chances at the bonus game. With 262,144 combinations, the bonus game starts every 262,144/512 or 512 games. This is pretty reasonable.

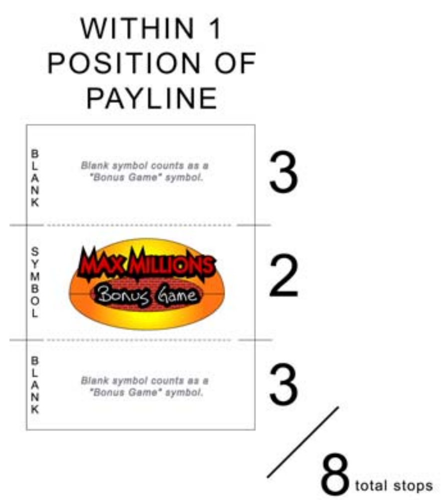
Some bonus games initiate every 60 to 80 games on average, especially on 5-reel video slots. However, the average win is much lower and a video slot with a maximum award of 50,000 credits is 20x smaller than ours.

By making the symbols count on or within one position of the payline, we give the player the impression that they're getting something extra. We could assign eight stops for the bonus symbol, and the player would see it land frequently. By making two stops for the symbol, and three for each blank around the symbol, we have the same eight stops for the bonus symbol. However, the player sees that a 'close' appearance of the symbol counts and they think they are getting the bonus round more frequently. WMS Gaming did this with their Winning StreakTM game and players were very receptive to the games.

Our next consideration was a payout for having only less than three bonus symbols landing on the payline. If we receive a bo-



nus-symbol on reels #1 and #2, but not on the third, then the bonus round does not start. Should the player receive some payment for this, such as 15 credits? We decided that since the bonus game starts very frequently, we don't need to pay anything for 'almost' getting the bonus round. We're giving an 'almost' payout from the bonus round, so in effect, we're giving the players something extra anyway.



There was also a great deal of math to perform in order to equal the payouts from the bonus game. The actual integration of the two games is not really that difficult. The next part is perhaps the key to the bonus game. Working closely with Larry, we were able to fine-tune the game and get the numbers looking good. The bonus game has its own math and PAR sheet to be calculated and refined. Once this is done, the figures from this sheet are placed into the base game. The modifications to the base game can be fairly complex, but not for the reasons you might think. It's only to make hit frequency reasonable without making the payout frequency grow too large."

After a few questions from the VP.s, Larry takes center-stage and explains the bonus round math and PAR sheet.

We had a clear direction from management on how the bonus game should pay. The documents provided to us outlined 14 different payouts, ranging from 10 credits to 1,000,000 credits. Using a 25-cent game as the base platform, the payouts would range from $2.50 to $250,000. The frequency of each payout was not specified. In order to determine how to integrate this game into the Blazin 7's base game, a number of options were considered. It was determined that a bonus game needs to consider two factors to be successfully integrated into a base game. These are:

(1) frequency of bonus game play, and
(2) average payout per bonus game.

Max Millions Math

AWARD	COMBINATIONS	FACTORS	EXPECTED VALUE
1,000,000	1	0.0001	100.0000
100,000	1	0.0001	10.0000
10,000	1	0.0001	1.0000
1,000	1	0.0001	0.1000
750	50	0.0050	3.7500
500	50	0.0050	2.5000
250	1300	0.1300	32.5000
150	1300	0.1300	19.5000
100	1200	0.1200	12.0000
50	1300	0.1300	6.5000
40	1360	0.1360	5.4400
30	1040	0.1040	3.1200
20	1200	0.1200	2.4000
10	1196	0.1196	1.1960
TOTAL	10,000	100.0000	200.0060

Larry explained, "In order to have the bonus game played frequently, the average payout must be low. To have a large average payout, the bonus game must occur infrequently. With a top payout of 1,000,000 credits, this will raise the average payout considerably. In order to make this work, we had to perform the following steps:

First of all, the top award must be infrequent. The more that the lower payments are paid, the lower the average payout will be. In order to have a high frequency of bonus game play and a low average pay, we determined that the possible combinations of each payout will be large. We experimented with many variations, and came up with this table(see Max Millions chart):"

There are 10,000 possible combinations in the bonus game. Just as virtual reels are assigned a number of stops for each symbol, each paying combination is assigned a number of stops. Unlike a regular slot machine base game, where the number of combinations of symbols determines the payout, the bonus game only has combinations of paying symbols. It's the same theory, but is simpler to apply.

The bonus game we've worked out satisfies all of the requirements we were given. By using a large cycle of combinations for the bonus game, we can have a frequent occurrence of the bonus game, with a reasonable payout. The top award occurs only 1x out of the 10,000 game cycle, but the average payout is 200 credits. That means that on average, the player will receive well above the lowest payout on the display. This will encourage players to play our game, going for the frequent, generous bonus games.

After a brief pause, one of the executives speaks:

During a meeting Friday evening, it was decided that we need to change our bonus game somewhat. Although we're paying out a top award of one million credits, we're not happy with our decision to use the bonus game in a 25-cent game. We want a million dollar award, but don't want to move to a dollar-machine. In the end, we decided that we need a $1,000,000 top award on a 25-cent platform. We need to increase the awards to $1,000,000 or four million credits, with the secondary awards of 1/2 a million and a quarter million dollars respectively. We would have let you know sooner but we had some logistics to work out and didn't make the final decision until this morning. I'm sure this changes a great deal of your work, but we feel it's important to get the game right before it hits the market.

"Actually, " you reply, "it won't be as difficult as you think. In fact, we can likely come up with some revised numbers here this morning. We'll have to change our math, but the basic method we used won't change all that much. Let me show you..."

In a few moments, you have a large spreadsheet projected on the wall showing the math you came up with on the weekend. "Because we're changing the major payouts by 4x, let's start with a simple solution. If we change the cycle from 10,000 to 40,000, we should increase all possible winning combinations by 4x as well. We change the large awards to only come up once, but with 4x the amount. The overall payout should be pretty close. Here's what we have. First of all, we take each bonus payment amount and multiply by a payment factor. The payment factor is the number of possibilities divided by the cycle.

"I remember reading about that in an issue of Slot Tech magazine", mentions one of the managers. "I think it was in the February issue, on PAR sheets".

"That's right", you reply. Here's how we do this:

Suppose that we have a 1,000,000 coin payout occurring once in 10,000 games. If we multiply the cycle by 4 and don't change any payout amounts, then nothing really changes mathematically. Now we have a 1,000,000 coin payout occurring four times in 40,000 games. If we want to increase the top award by 4x, then we decrease the frequency of it happening by 4x. Now we have a 4,000,000 coin payout occurring once in 40,000 games.

We do the same for each paying possibility, adding up all of the results. You see, what we are doing is factoring each payout by the probability it has of happening. The total is the average payout. Now, by changing the numbers a bit, here is what we have. Maybe we'll change the upper payouts to make them a little bit more even, it won't take too much."

You change the cycle values and the payout spreadsheet revises on the screen. As you tweak the numbers, you try to increase the maximum payout, while keeping the overall avergae consistent. It will take more work to get the final results but at least you can give everyone a pretty good idea of where you're heading.

Now, the game that Larry and I came up with on the weekend (you emphasize the word weekend), had an average payout of 200 credits. You'll note that this one has an average payout of only 185 credits. By increasing the cycle, we can lower the average.

"I'm not sure that I'm following you. How do you do that?" asks a puzzled manager.

"Think of the maximum payout. It's 1 million coins. That is going to bring the average WAY up. Sure, we made it 4x as large but we increased the cycle by a factor of 4x as well. That means that instead of 9,999 payouts smaller, there are now 39,999. The more payouts we have in the cycle, the less any one payout affects it. If we have a cycle of 1 million bonus games, a payment of 1 million dollars doesn't have that much affect on the overall game. Consider a standard slot game on the floor. The Piggy Wiggly game has a top jackpot of $50,000 on a 2-coin, $1 machine. If the jackpot hits on the second game, then we've had four coins in and paid out 50,000. That's a payout of 1,250,000%. However, if we have 2,000,000 coins in, a payout of 50,000 is only 2.5% of the total coin-in. It doesn't affect the overall total that much. The same applies in the bonus game. It has its own cycle, and contributes its own amount to the overall payout of the entire machine."

"Let me see if I understand this correctly." interrupts the CEO. "Are you saying that we could pay out $1 billion dollars on a quarter machine, if we have enough combinations? Or, we could actually offer a penny game with a million dollar jackpot?"

"Yes, absolutely. Remember, though, that in order to do that you need a large cycle. Consider it another way. Players often have the mistaken idea that a slot machine must bank up the winnings before they are paid out. Although in theory you might say this could be accurate, it only happens this way over the long term. The slot machine may pay out the jackpot before it has banked the amount, or after. It doesn't consciously try to bank it up. In the end, the math always works out. It always does. You just have to trust it. If you are going to pay out $1,000,000 on a 1-cent game, that's 100,000,000 credits. You must, in the long run, take in at least 100,000,000 pennies to make up this contribution of the jackpot. Consequently, the bonus game will have trillions of combinations in its cycle. You may go 30 years before the jackpot is paid. If it happens to pay out on day 1, you're a million dollars in the hole. You won't have these games on your floor for 30 years, so you'll never break even. You do have to match the payout with what you can reasonably expect from the game. A 40,000 game cycle on a game is quite reasonable. On that game, you're going to hit the jackpot a number of times. Although anything can happen in theory, there is a limit to what is practical."

"That's why we have the MacroMega Jackpots. In order to pay out these millions of dollars, we link the machines together."

"Exactly. If we have one machine that pays out 1,000,000 every 10,000,000 games, then having 10 machines contributing to it we pay out every 1,000,000 games. It's not quite that simple, but it is similar to that."

"So if we want a penny game to pay out $1 million, we link 1,000 of them together. That way, we collect the coin-in from many games and contribute it to the common jackpot."

"Exactly. In fact, I think that's going to be covered this fall in Slot Tech Magazine, according to my sources there."

"Fine. Now, can you explain how this bonus game fits into the base game, and how it affects the payout? I think I have a handle on the bonus game, but only as a separate game. How do the two of them come together?"

"That's an excellent question," you reply. "If I can have a bit of time to tweak the numbers for the new bonus payouts, I can explain everything and show you how it all comes together. That way, we'll be working with actual figures and it will be a little bit easier to explain."

The group agrees to break until the following morning. You have the rest of the day to fine-tune your figures, but it isn't going to be too difficult. Next month, we'll see how it all comes together.

- John Wilson
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