September, 2002

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**Global
Gaming
Expo**

Randy Fromm

Well, another TechFest has come and gone, and another trade show is on its way.

TechFest 3 was held August 14 – 16, 2002 at the Boardwalk Hotel and Casino in Las Vegas. Advanced Electronics Systems, Inc. hosted the three-day event, along with luncheon sponsorships from Asahi Seiko, 3M Touchsystems, Wholesale Electronics,

Medeco Locks (VSR Locks), and Sencore. A big Slot Tech Magazine thank you to all of these sponsors as well as those companies that gave technical presentations: Asahi Seiko, 3M Touchsystems, Coin Mechanisms, Inc., Mars Electronics International, Sencore, Ceronix, and Seiko (printers). Look for more TechFest coverage in next month's Slot Tech Magazine. There just wasn't enough room in this jam-packed G2E show issue. TechFest 4 is slated for Minnesota, October 22nd – 24th, 2002.

The much anticipated Global Gaming Expo finally arrives this month, September 17 – 19, 2002 at the Las Vegas Convention Center. Slot Tech Magazine will be there at booth number 2771. Please stop by and say hello while you're strolling the show floor. Also, I will be giving a special, two-hour presentation on Video Slot Monitors on Friday, September 20th at the conference. It's session number 4045 - Tech Corner: The Basics of Video Monitors from 2:15 PM - 4:30 PM

This seminar assumes no previous knowledge of electronics and is geared for slot techs who now find that 80% of their slot floor is video where it was 80% reel slots just a few years ago. The seminar covers the theory of operation of monitors and presents even the most novice technician with a method of quickly narrowing down monitor problems to a small circuit or group of components. It's a method that allows techs to be successful at monitor repair without an advanced knowledge of electronics.

This month, Slot Tech Magazine respectfully scoops all of the other gaming industry trade journals with an exclusive, in-depth look at the technical aspects of MEI's spankin' new bill validator, the CashFlow SC66. This remarkable new BV sports advanced, multi-wavelength optical recognition as well as a completely re-designed, plastic cashbox that will challenge even the most destructive (read efficient) drop team. Read all about it starting on page 16.

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

Randy Fromm

YOU
ASKED... WE
LISTENED.

JCM offers new solutions to your currency handling needs.

SENTRY,™
JCM's Smart Entry

JCM's SENTRY displays acceptable bill denominations and coupons, faults, errors and cashbox status using easily identified colored LED icons. SENTRY's function and appearance enhance game appeal to the players, and maintenance for the operators.

Intelligent
Cashbox System

JCM's new cash-handling system uses a memory module, reader, and printer to efficiently eliminate errors in the conventional soft count process.
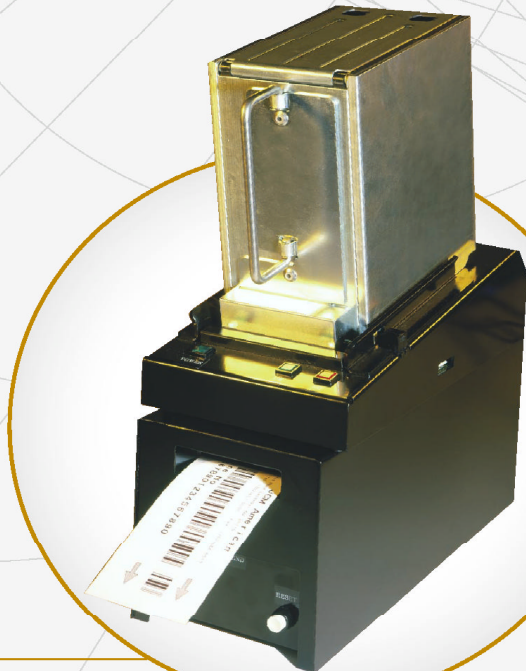
SECURITY. TECHNOLOGY. SOLUTIONS.

JCM AMERICAN CORPORATION

The Bally 7- 05 Main Upgrade

By Kevin Noble

The Purpose: The known purpose for the new upgrade was to prevent the bills from stopping between the Bill Validator and the cashbox. Many security improvements (which we are never told) could be another reason for the rush on this project. These new mains also have the capability to use the new cashless (printer) system.

The Procedure: In Ontario, we have one of the strictest gaming regulations, from what I have been told by numerous people in the business. This is an example procedure for a bank for games that we do.

1. Take first set of hard, soft and Mikohn meters around midnight and disable the games.

2. First thing in the morning the EGO (Electronic Gaming Officer) arrives at the games to verify the meters were taken correctly, at the same time break all the seals on the Supplements, mains, and RAM.

3. Perform the SafeRam clear, insert new EPROM'S, and reset all options.

4. Complete the 6 point inspection sheets. In these inspections we are checking for burnt out lights, missing, worn or loose parts, all switches functioning correctly, locks, correct IDX'S, hopper tests, pay table tests, just to name a few.

5. Another important part of the inspection is coin testing. Playing 5 coins to the hopper, grounding the probe, and 5 coins to the drop. Verifying the diverter and the meters are all incrementing. Next comes the live bill testing. Inserting one of each bill into the BV, cashing out, and ensuring all those meters have incremented.

6. The last part of the Technicians inspection is the taking the second set of meters. Making sure the soft, hard and Mikohn meters all incremented correctly. After verifying that all the information has been filled out, the tests performed correctly, the boxes have been checked off, and the game is 100% in working order, we can make arrangements to call the EGO officer.

7. The next step is when the EGO officer verifies all the EPROM'S on their lap top computer, and reseals the EPROM'S on the board.

8. Next is the EGO'S final inspection. Basically they perform their own 6 point inspections which include pay table, hopper, and coin testing. All machine functions are working correctly, correct part numbers in the games, and coin testing.

9. Finally the last part of the inspections from the EGO officers is to verify that there coins and credits that they played incremented correctly and the all meters are matching. This is where we take the third and final set of meters on the game.

10. Depending on the size of the bank this upgrade can take from 1 to 2 days to complete. Other factors that could prolong the upgrade are the Technicians available, the schedule of the officers, unforeseen game malfunctions, security escorts for the bill testing and the calls on the floor

The Improvements:

1. The most noted improvement of this upgrade is the fact when the coin mech switch is shut off, the game will not accept any bills not like the 6-03's.
2. The new options are included to use the printer options if it is available to your site.

The Bugs Noticed:

1. When the reset switch is turned with the door closed, the tower light will remain on until the main door is opened and closed.
2. Constant 83F c's, d's and e's are displayed after the CPU board was removed from the game after it was cleared and set. We had to have the EGO officer rebreak the seals after they were sealed, and re-perform the 6 point inspections. These of course require the full RAM clear to be performed.
3. After soft drops were done we found many 70 codes and 55 codes where the main door needed to be opened and closed.
4. For the Mikohn system the M00 codes were back, but not as much. This meant that the M00 codes needed the partial clear to get rid of them.
5. Shutting off the coin mech switch did not completely disable the game. You were still allowed to play off your credits.
6. The machines are still locking up and you are not able to reset them. The IDX and BV are disabled. This also needs a RAM clear.
7. There are 80 codes which can be reset by either using the reset key or turning the game on then off again. If this fails, a RAM clear is needed.
8. Constant 91 codes on the progressive games. You can reset it sometimes, but it is usually accompanied by an 80 code. This will need a RAM clear.
9. The BV is still going to sleep. You need to reset them.
10. When a customer is cashing out credits and the game goes into a hopper empty code 32. Once the hopper is refilled
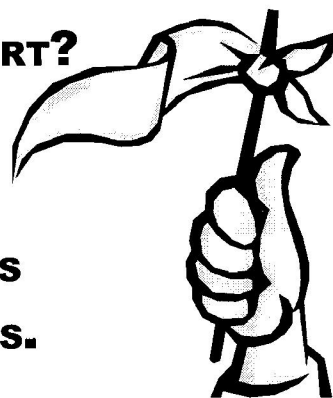
and the door is closed the hopper will start to pay out before it counts down to "0". This causes the game to go into a overpay tilt condition.

A) If you open and close the door to clear the tilt condition, the machine repeats the countdown and before it reaches "0" it tilts back into the overpay condition. What you need to do is open the door, shut off the coin mech switch, close the door and allow the hopper to complete its pay out. Then you must reopen the door, turn the coin mech switch back on and close the door. The game is now ready for play. or

B) Hold the reverse button on the hopper, shine a light on the door optics, once the game has counted to zero, and the game starts to make the loud dinging noise and then release the reverse button. You must allow the game to complete the payout. Or

C) Jump the hopper optics on the driver board to the second position, close the door and let the machine count down, open up and return the jumper to the original position. These are three ways we use to clear these codes. Not all the time the same one will work and usually we have to try the different solutions.

11. If you insert coins or credits on the game, but you do not press the bet max button, but press the change button. This will cause the insert coin display which has been showing a "2" for example, to go dim while a "0" will now super-impose over top the "2". Now your display will read the number"8" or a faint"0".

12. If you bet 1 or 2 credits on the game (long as it is not max credits) the insert display will show the amount you have bet. Now when inserting a bill into the BV, the insert coin display will now read "0". The winner paid meter will show the amount of credits for the bill and the credit meter will also add the amount equal to that of the winner paid meter. Now you have not lost your coins/credits that you bet, even though the display is reading "0". All you need to do is bet one more coin/credit and the insert coin meter will now the correct amount wagered.

13. Using the same procedure as above (#12), when the bill is inserted and the insert coin display reads "0", the machine allows for the patron to cash out their credits from the bill along with the one or two coins first wagered.

- Kevin Noble
knoble@slot-techs.com

BALLY 7-05's							
	G	S	P		G	S	P
27	1			58	LOCK-UP		
26	1			59	0		
9	6			6	0		
10	DENOM			57			
11	1			12	0		
2	0			90	0		
7	0			91	0		
18	0			94	0		
80	0			95	0		
1	0			73	0		
47	1			76	0		
38	0			61	0		
48	7			81	1		
50H	MACHINE			74	0		
50L	ID #			64	0		
54	0			67	0		
56	LOCK-UP			14	0		
62	0			77	0		
63	0			8	0		
78H	0			5	0		
78L	1			20	0		
4	0						
51	LOCK-UP						
3	0						
22	0						
70	0						
71	0						
72	0						

The X-20 Xeptor™ Attacks!

It's Time To Stop Simply Comparing Coins And Start Measuring Coins

Bi-Metal Coin Signature

The X-20 has unique small geometry metal sensor coils that measure the signature of the coin on both the edge and the center of the coin. The large, oblong and deep-seated coils of other acceptors haven't a real chance of separating the signatures of edge and center alloys.

Clad Coin Signature

The X-20 uses advanced multi-frequency sensing techniques to resolve separate layer signatures from clad or plated coins, such as the nickel clad copper construction of the US 50¢ in the picture. Most currency produced today for US, Canadian and the new Euro coins is clad or plated.

Diameter Measurement

Precision optical diameter measurement with 0.005" resolution allows the X-20 to eliminate the shaved coin problem that plagues simple comparators and results in tricking hopper counters to overpay customers. The solution: Just Don't Accept Shaved Coins!

Triple Track™ Technology

Your best customer can insert up to 15 coins per second. Ten is just not sufficient for fast fed coins. The unparalleled acceptance rate of the X-20 is due to its ability to measure, track, and properly credit as many a 3 coins simultaneously traveling down the coin chute at any given moment.

Sophisticated Credit Optics Logic

Xeptors can be optionally ordered with built-in credit optics. The X-20's sophisticated sequencing and timing logic combine information from the credit sensors and other internal sensors to provide a complete defense against stringing, soda straw tricks, and taped coins, based speed, direction and path.

Personality Plugs™

Personality plugs adapt a single Xeptor model to any of many industry standard electrical interfaces. More than a dozen Personality Plug modules are available to ensure compatibility with machines requiring any of 24VAC, 24VDC, 12VDC, Tilt, Credit, Sense, and Inhibit signals… or custom..
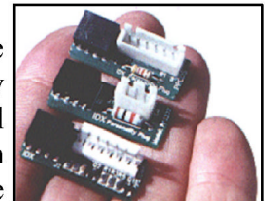
Learn'n Run™ Or Download

Manually program the X-20 by pressing buttons and dropping coins, or just use the *X-20 Selector* to download coin signatures at the touch of the button. The *X-20 Selector* will also secure the Xeptor from manual programming if not present.

Spill Proof Construction

Xeptors are the only coin acceptors designed to shed spilled liquid. No exposed card edges, no gaping holes for wires and pots. We just keep the sticky conductive stuff out.

Full-Open Coin Release

Stop digging bent coins out of comparators with screwdrivers that just rip them up. Even those half-flap acceptors require the screwdriver treatment now and then. Only Xeptors are deigned to fully open on your command.

Auto-Tune™ Technology

Mr. Xeptor never sleeps on the job. When no coins are coming through, he is busy re-calibrating the nine optical sensors and two inductive sensors. He also tracks long term coin data averages so acceptance windows for coins stay centered.

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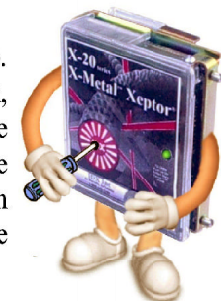
Have Fun or You're Fired!

By Ken Locke

"There is no perspective that is more valuable or more significant than the technicians'."
Ron Brooks - Director of IGT Casino Services

T*he new Director of IGT Casino Services loves every minute of his job. Ron Brooks give us insight into the world's largest slot tech shop, his views on management and an exclusive glimpse at the future of gaming platforms.*

STM: How long have you been with IGT, Ron?

RB: I started as Director of Quality in 1994. We centralized all the quality functions, at least from an operational standpoint. We basically put a lot more emphasis on pro-active defect prevention and customer focus, as opposed to 'just-separate-the-good-from-the-bad.'

"And three months ago they asked me to be the Director of Casino services."

STM: How's that going? Techs are a different breed than engineers. *Truth be known, we'd really like to give all of them a big collective noogie sometimes.*

RB: Good, I am a bit used to being closer to my employees. We're so spread out geographically. I am working in probably 30 different cities with seventeen branch offices. And, then if you factor in the SODAK locations, there's another five. Plus a whole bunch of remote techs out there.

STM: You picked up Anchor Gaming?

RB: Yes, in April. That brought in another eight-six people right there. If you take the entire IGT organization, plus SODAK, plus Anchor it's over 600 folks. That includes, of course, parts distribution, logistics and support personnel.

STM: I think it's the technicians who truly buy the machines. When someone becomes a new slot director, many times it is a person with very little gaming know-how. They have, perhaps, a business degree but not much knowledge in the way of how slot machines work. When it comes down to it, they are turning to their knuckle-busting techs for answers.

RB: And they should be. There is no perspective that is more valuable or more significant than the technicians'. Whether it is the property's technicians or ours. That is a hands-on perspective that there is no substitute for. The host of things that that technician will experience first-hand must effectively translate back through the organization. Good news or bad news, it's very important.

STM: The New York gaming jurisdiction is about to bust wide open. What advice would you give a new slot director in New York to get his technicians trained and up
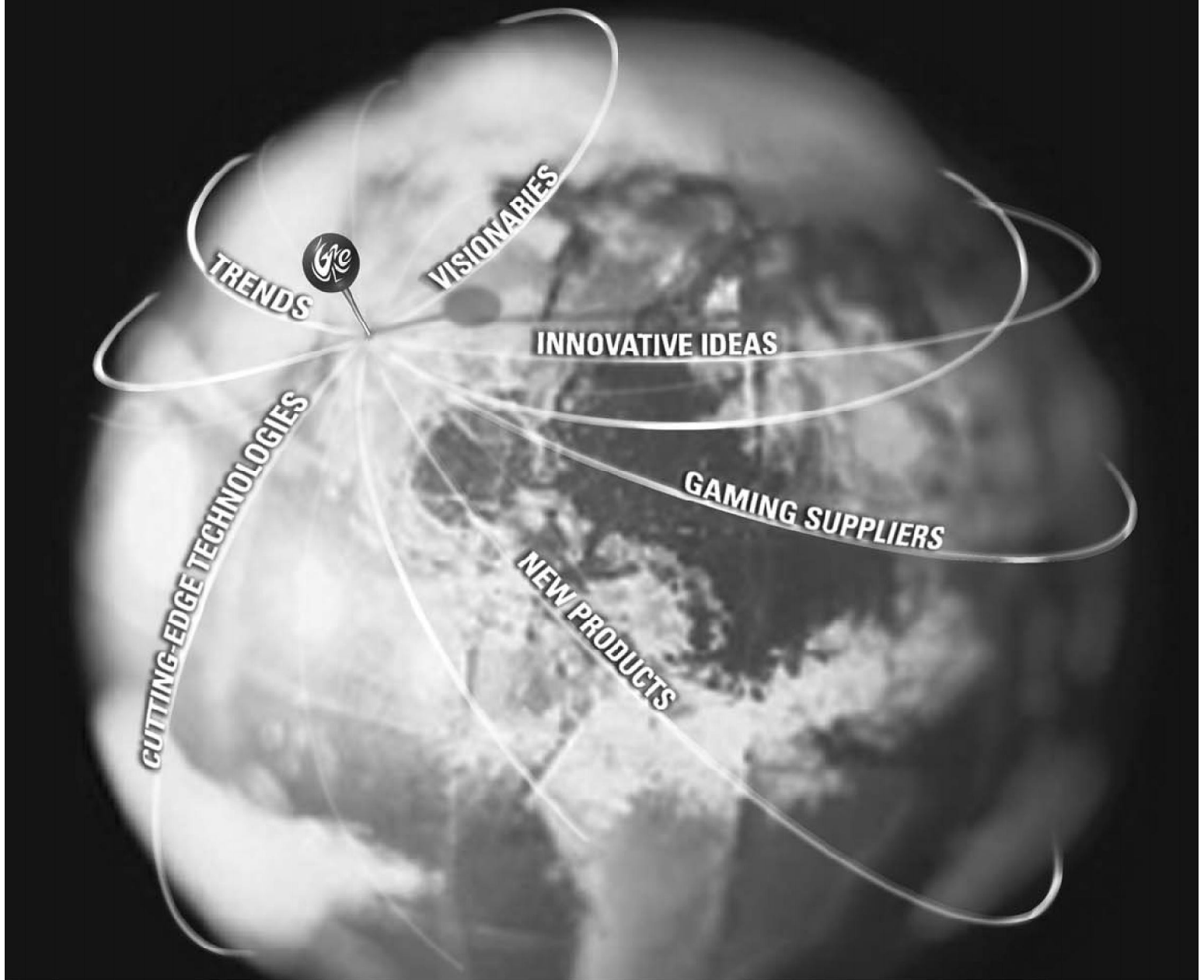
Ron Brooks
Director of IGT Casino Services

to speed?

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"I think the customer can sense that we're having fun."

RB: We have some pretty basic courses in IGT University. If we are selected as one of the VLT suppliers we are going to find a good market in New York. We are going to want to hire as many local techs as possible and we have to assume the vast majority is going to know very little about gaming. So we have an opportunity to show leadership in the form of well documented and proven courses that can bring somebody up from scratch and provide a high level of training. It's going to be a big deal. They are going to have as many as 11,000 slot machines there pretty quick.

STM: Are you worried about New York being able to handle such a huge undertaking?

RB: The New York Lottery is a very good and efficient organization. They are hard working and ambitious and do a very, very good job.

STM: Sounds like a little Native New Yorker pride shining through there?

RB: Oh, sure. I expect to see a lot of jobs created in New York to be filled by local folks and we see ourselves in a great position to do just that.

STM: Let's talk about Casino Services' reputation.

RB: You know it's so easy for a company like IGT, that has such a huge market share, to be perceived as arrogant, even when it's not. I believe we need to go to the other extreme; to be as humble and supportive as we can be.

STM: I agree. It's no secret that IGT is the 800-pound gorilla. If you want to open a casino, all roads lead to Reno. That having been said, you probably don't have to flaunt that.

RB: Absolutely not. We [in

Casino Services] want to be a competitive advantage for IGT and I believe we are. That's what this company is all about. I want to overwhelm the customers at every level with the best quality service in everything we do.

STM: With the new ticket systems out there, techs have a new component to learn. What does a tech need to know next year? In two or three years from now?

RB: Well EZ Pay is one thing. And there is certainly a new skill set there. But what I think will be even more daunting will be the new product lines coming out this year.

STM: What's so new?

RB: Now we're moving into a significantly higher level of technical complexity. It's a quantum leap from i960 to the new platform. It's safe to say they will have to be

more of a computer technician. It's completely PC-based.

STM: CD-ROMs?

RB: CD-ROMs, hard drives. We're certainly seeing a shift from what was at least partly mechanical to the completely electronic and away from moving parts and coins.

STM: Some techs may think they have a lot to fear about new technologies but I think it's about initiative and embracing the new stuff.

RB: That's right. You could argue that the gaming industry or the collection of equipment that's come to be known as gaming devices may not be as high-tech as some other things but it's still seen its share of migration over the last twenty-five years, going from extremely mechanically oriented devices to really complex technology. The industry is not new to innovation. The techs that are already out there have had to make continuous improvements in their skills over the years.

STM: Let's talk about parts. Ceronix versus Kortek. What's the story there?

RB: We're doing both. Ceronix is certainly still one of our key suppliers. There was a time in IGT history that we were using single-source suppliers. We found that it can be very dangerous if something catastrophic with one supplier occurred,

especially with such a critical part. So we have dual suppliers, in fact, on virtually every one of the thousands of parts in our machines, to make sure we're always covered. Our customers are covered as well. We worked long and hard to pick the supplier. We considered many suppliers and evaluated their product. We measure the quality of a supplier's product on the production line and in the field, and Kortek has consistently performed well. We will not allow a product to become substandard.

STM: Is that the secret to your Quality Sauce?

RB: Exactly. You are what you eat. We look at the quality of our incoming material. To become a qualified supplier with IGT is not an easy thing to do. And, its not an easy thing to stay one either. We have certainly had a few bumps in the road over the years but our suppliers stand behind their product and we work together to make it right as quickly as possible. We look at our suppliers as long-term partners and we invest in each other's success.

I think the customer can sense that we're having fun.

STM: I hear you have a philosophy.

RB: It's really based on four words. The first word is Customer. What does your customer want, what does he need and are we doing everything to delight him? And I translate that same fanaticism to our internal customers as well.

I think the customer can sense that we're having fun.

The second word is Responsiveness and this case, may be 90% of delighting the customer. In other words, what is the cycle time of our response? How fast can we move? It's also about our first reaction. Let's make sure our initial knee-jerk reaction is positive and professional.

The third is Respect. There are some very subtle ways of disrespecting someone, including not responding at all. Our behavior gets to the heart of cooperation between people and organizations.

Number four is simply Fun. I feel very strongly about this. I have a very pragmatic belief that if we're not having fun at our jobs, we not being as productive and creative as we can be. If we want to continue to be the leader in this industry, we really need to be having fun. When we're having fun, that's when we're bringing a level of passion and inspiration and commitment to the job.

STM: Your guys tell me that you say to them "Have fun or you're fired."

RB: Well of course it's tongue-in-cheek and meant as a joke but it underscores a couple of things. First, it illustrates how much I believe that fun is an important part of a good work environment. And it's a statement that you can never truly force someone to have fun. You can, from a leadership perspective, create an environment that helps them have fun. When I say 'have fun or you're fired,' I don't expect work to be a country club. I expect my people to work very, very hard but I also expect them to have fun while they're doing it.

This was something I learned while employed with my last company. I wasn't having any fun at all. I mean, I just hated going to work. Then I had run into a friend of mine who was a cop. He said, "I just love going to work. I get up in the morning and I just can't wait to get there." This was, at the time, a foreign concept to me. What an unbelievable thing. I thought what a lucky bastard. At that point I made a goal to figure out a way to have fun at my job.

STM: How did you do it?

RB: I just consciously decided to fall in love with job, fall in love with product and fall in love with people I worked with. When you do that, it's like you don't even work. It's when you integrate fun into work that you fall in love with your job.

Hear that guys? It's all about the love.

- Ken Locke
- Ken.locke@igt.com

Acres Launches NexGen™ Touch Screen

Interactive multimedia display paves way for new generation of Bonusing

Acres Gaming Incorporated announced it would begin deliveries of its "Next Generation" interactive multimedia display later this calendar year. The new display, already approved for use in Nevada and California, will dramatically improve communication of casinos' marketing and loyalty programs directly to players at slot machines.

Acres' NexGen Display is a 6" X 2.25" touch screen color LCD that is five times or more the size of the single color text displays currently in use at most casinos. Casino marketing and loyalty programs will be communicated to slot players utilizing 16-bit color for photo realistic imaging, MPEG video and MP3 stereo sound technologies.

Bud Glisson, Chairman and CEO for Acres said, "Our new NexGen display adds a heightened sense of fun and drama to the player's receipt of casino promotions, loyalty rewards and marketing communications. With NexGen's interactive multimedia features, our current Bonusing products can now be delivered in a more entertaining and easily understood manner. NexGen also gives us a delivery vehicle for a whole new range of Bonusing products with unprecedented creativity. We've set yet another industry standard of excellence with this new display."

The NexGen display was designed to significantly increase a casino's marketing capabilities in conjunction with Acres' proprietary Bonusing Software. It works like an ATM touch screen to guide players through casino promotions, loyalty programs and cashless gaming transactions with the help of interactive video screens and digital voice prompts. A P.I.N. pad automatically appears on the display when a player's P.I.N. is needed for a secure transaction such as accessing Acres' non-cashable Xtra Credit®. Through Acres' Multimedia Content Manager, a casino can customize the messages it sends to its players and promote casino restaurants, entertainment and special events. The display maximizes the entertainment value and branding opportunities of a casino's communication with players at the slot machine.

The Sahara Hotel and Casino on the Las Vegas "strip" and Lakeside Inn and Casino in South Lake Tahoe are scheduled to be the first venue-wide implementations of the NexGen interactive multimedia display. Acres has already secured contracts for complete systems and bonusing from the two Nevada casinos, both scheduled for installation later this calendar year. The product will be highlighted at the Global Gaming Expo in Las Vegas this September.

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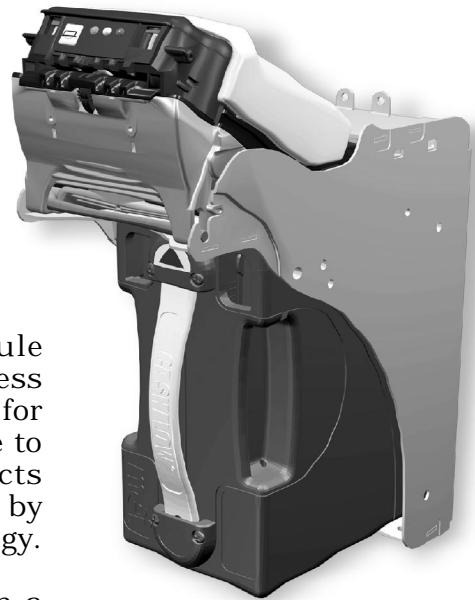**Ozzy's Challenge** is an Ambassador premium gaming solution.

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MEI CASHFLOW SC66
Technology Review
Contributed by Neil Young, MEI Marketing Manager

When I talked to Randy about writing this article, he made me promise to focus on the bill acceptor technology, not on marketing hyperbole. I'll do my best, but we're talking about a tall order for a marketing guy, especially when talking about this product.

The MEI CASHFLOW™ SC66 was designed for optimal bill acceptor performance in a ticket in / ticket out world as a new, "ground up" design. Although the MEI ZT 1200 has proven a formidable competitor to JCM's WBA, to move the game forward required an entirely new platform.

Product Overview
The basic product architecture has several key differences from current casino bill acceptors. As you can see from the picture, the bill acceptor module is more compact than the current WBA or ZT recognition units, while fitting within the overall space envelope. The bill path is much shorter in this product. When a bill enters the unit, it is transacted through the acceptor head, transported down the front of the cash-box and stacked toward the rear of the unit.

The other new element is the interface card. Gaming machines currently run a variety of electronic interfaces (opto-coupled, RS 232, etc.) to the bill acceptors and are likely to change in the future. In the MEI CASHFLOW SC66, the inexpensive interface card can change depending on the OEM machine interface. The more

expensive acceptor module will be the same, regardless of the OEM. This allows for reduced spares holding due to common parts and protects your property's investment by allowing for future technology.

The interface card slides on a "PC style" edge connector in the chassis. The acceptor module automatically connects to the interface card when latched to the chassis. You can swap both modules in machines on the floor without removing the cash-box.

Bill Recognition / Processing
To understand the new recognition system, you need to understand the basics of optical bill recognition. In a transmissive optics system, light from a Light Emitting Diode (LED) is beamed through the bill to a photo-detector. The resulting signal measures the properties of the inks and the substrates (materials) of the currency. It is the differences in response between real currency and counterfeits that form the basis of security in optical systems.

An LED, based on its material composition, emits light at a very specific wavelength when energized. The materials in the currency respond differently to each wavelength of light so generally speaking, more wavelengths beaming through the currency at a given spot provide more information for security analysis.

The current MEI ZT 1200 uses three wavelengths of light from three LEDs housed in

one metal can package. Plastic lenses convert the outputs of the LEDs (which are point sources) into columns of light.

While this arrangement was the most advanced optical system in the market, there are limits to its expansion for a number of reasons. Each LED needs to be close to the focal point of the lens. The individual LEDs need different current inputs for a given light output and age (fade) at different rates that require complex compensation circuitry to maintain consistent signals. Additionally, each individual light column covers only a small portion of the bill's surface. While more LED packages could be added to increase coverage, it would add cost and complexity to the product.

MEI engineers solved these issues with the revolutionary light bar system in the MEI CASHFLOW SC66. In this system (pictured below) the output of LED dies in six different wavelengths reflects into a light mixing bar.

The light bar, augmented by specialized light control films, directs light upward in a wide, uniform light field to scan the bill. The data output is col-

lected by a system of lenses on the other side of the bill path that focuses onto photo-diode receivers. This patent pending recognition system scans up to four times more of the bill's surface than conventional bill acceptors.

The output of this recognition system requires significantly higher processing power in the MEI CASHFLOW SC66. A/D converters digitize the analog output from the light bar system. The digital data flows into a state of the art, 100 MHz Digital Signal Processor (DSP). A DSP is unique because it processes data in real time. This capability makes a DSP perfect for applications that cannot tolerate any delays. The DSP firsts digitally reconstructs the bill image. Then, using the DSP's power to transform data, MEI employs sophisticated recognition algorithms. This greatly increases the speed of acceptance (about 2.5 seconds from bill to bill) and provides outstanding security.

The DSP also processes the output of a custom bar-code sensor. Unlike bar-code scanners in retail that can take multiple passes and error correct to determine a bar-code, bill acceptors only get one pass for data as the bar-code ticket is transported past the sensors. By using the DSP architecture, the entire input signal can be digitally recon-

structed and processed with algorithms for the best ticket acceptance.

New Bill Transport

Fact: During the last five years, the US Federal Reserve, on average, destroyed more than 40 percent of all bills in circulation annually due to wear and damage. To think about the impact, consider the results in a side-by-side competitive trial with the ZT 1200 early this year. The ZT 1200s had slightly lower acceptance rate percentage than the competitive product, as measured by the central system, yet were accepting 33 percent more notes per day. This "mystery" was solved when the property discovered that the competitive unit rejected poor quality bills early but never reported these early rejects to the central system, hence the higher reported acceptance rate.

Editors Note: I questioned Mr. Young on this statistical claim, demanding some sort of proof as none was proffered in this article and the "property" mentioned in the paragraph above was unnamed. With my agreement of confidentiality in this regard, he then provided sufficient information that I can vouch for the veracity of the statement above. -ed.

The valuable lesson here is at the end of the day, it's the

amount of cash in the cash-box that counts, even if the money is in poor condition. Considering the percentage of US bills in that condition, this is a critical dimension of bill acceptor performance.

The MEI CASHFLOW SC66 attempts to accept all bills, without early rejects. To do this without the risk of a jam, MEI designed an entirely new bill transport system allowing the transaction of currency in all conditions.

Open Acceptor Bill Path
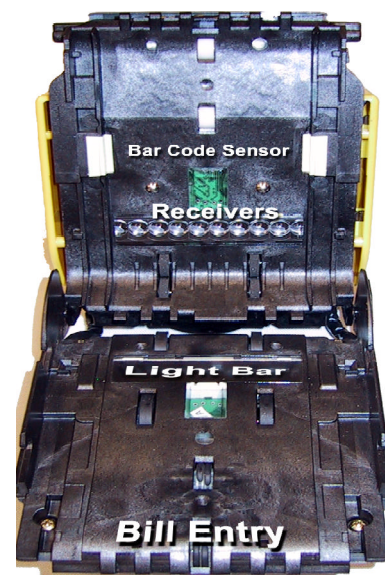
As you can see in the photo, the bill path in the acceptor is short and smooth. The plastics used in the bill path are formed in an MEI patented process. The clear sections (e.g. around sensors) are molded in Lexan 241. The black sections are then molded in Lexan 500 around the clear sections to form a seamless part. The MEI CASHFLOW SC66 acceptor is sealed against fluid and dust, so customer spills (as in bar-

MEI engineers have developed revolutionary light bar system in the MEI CASHFLOW SC66. In this system, the output of LED dies in six different wavelengths reflect into a light mixing bar.

mei ™

MEI introduces a new level of technology: MEI CASHFLOW™ SC66

MEI has designed a new bill acceptor for optimal performance in a ticket in ticket out world. The MEI CASHFLOW™ SC66 is equipped with more advanced processing technology, new algorithms and progressive engineering. The result is a significantly more sophisticated, and yet a more durable and reliable unit that increases cashflow.

The new technology solves many of the most critical problems that reduce cashflow in traditional bill acceptors.

Industry Problem:

Rejection of legitimate, but battered bills. Most bill acceptors can handle pristine bills. But, the vast majority of currency has seen some wear and tear. This is where traditional bill acceptors fall short.

MEI's Solution:

The MEI CASHFLOW™ SC66 attempts to accept all bills, without early rejects. To do this without risk of jam, MEI designed an entirely new bill transport system, which allows the transaction of currency in all conditions. Combined with an advanced bill recognition system, this greatly increases acceptance rates and reduces jams.

Industry Problem:

Acceptance of Counterfeit bills. Acceptance of counterfeit bills is the only thing worse than rejecting a legitimate bill.

MEI's Solution:

The MEI CASHFLOW™ SC66 scans 300% more of the surface of each bill than traditional bill acceptors using 6 wavelengths of light to scan each bill. The data flows into a state of the art 100Mhz Digital Signal Processor using sophisticated recognition algorithms. This greatly increases bills per minute acceptance, with tighter security.

Industry Problem:

Damage to the cash box during handling. Handling of the cashbox from the floor to the cashroom has always been the single biggest obstacle to reliability. Inevitable dropping and mistreatment eventually takes its toll on the mechanism and impacts the jam rate of the system.

MEI's Solution:

Strength is the key for durability. The cashbox is constructed of a durable, high impact plastic designed to provide superior protection of internal mechanisms against the harshest of treatment.

Industry Problem:

Dollar dispute. When a customer disputes a bill, the traditional solution was to open up the machine and the cashbox, incurring operator expenses and increasing downtime yet again.

MEI's Solution:

MEI incorporates an ingenious "Dispute Window" which shows the value area of the last bill stacked in the cashbox without removing it. This greatly expedites the resolution of customer disputes.

MEI CASHFLOW™ SC66 – Setting the new performance standard for gaming bill acceptors. Call us today!
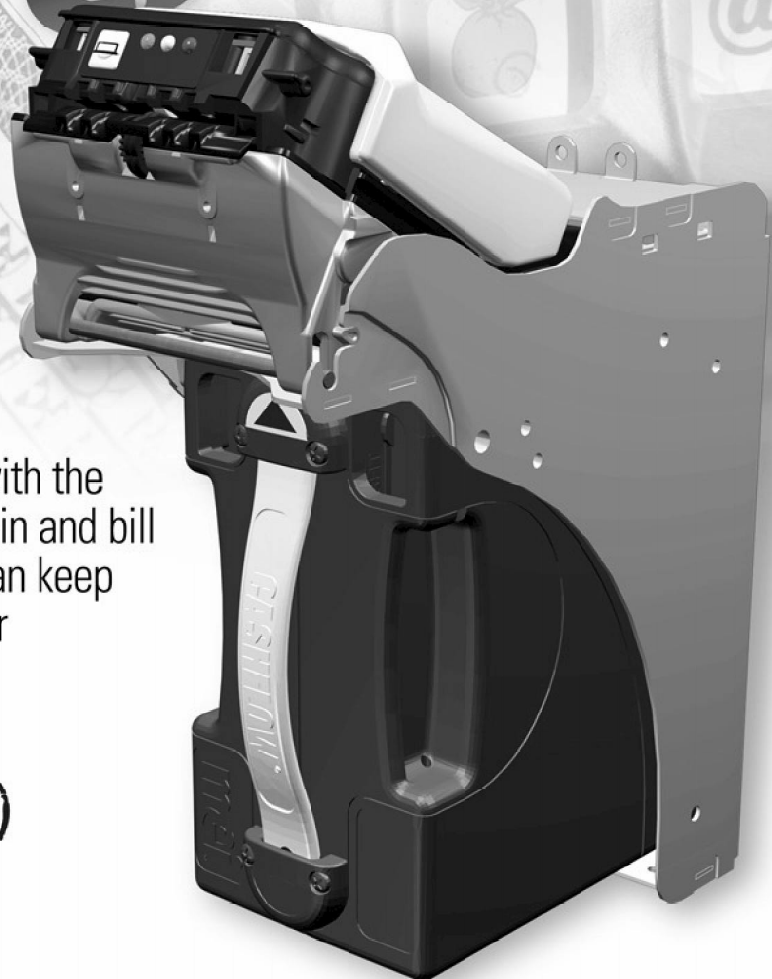
tops) will not result in failures. It is also easy to clean, though our experience with the optical system in the ZT suggests that cleaning need only be done about every two years, compared to the six month cleaning requirements of competitors.

The acceptor module features sets of rollers driven through a continuous spur gear drive with all the gears protected in the lower housing. The only exposed gears are central spur gears to transfer drive and stacker power to the cashbox.

The gear drive system is continued into the cash-box.

Stacker module in cash-box
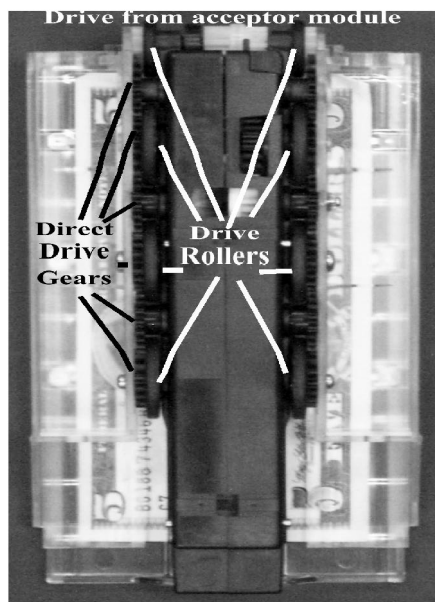
The internal cash-box stacker module in the picture is viewed from the front of the cash-box. As you can see, there are eight rollers driven by spur gears on both sides of the assembly. Competitors have claimed "belt-less" designs before. If you look at their designs, they are actually "drive-less" since positive control of the bill ends at the entry of the cash-box. This design fully controls the bill until it is stacked.

Combined with the advanced

bill recognition system, this bill handling system greatly increases acceptance rates of less than perfect bills while reducing jams. Based on the average number of bills per day in the 24/7 casino environment, the unit should jam only once approximately every three years.

Super Cash-Box

Drop crews are aptly named: the cash-box is most used and abused module of the bill acceptor in operation. One of the lessons MEI learned with the ZT was the need for a more durable cash-box. It turns out that damaged cash-boxes can generate jam rates as high as one in every one thousand notes. As the cash-boxes migrate from machine to machine, it can be difficult to detect the problem.

The MEI CASHFLOW SC66 has an innovative cash-box, constructed of a durable, high impact plastic. In development, MEI actually soft tooled the entire cash-box shell to experiment with the properties of different materials. The best material tested was a blend of polycarbonate and ABS, which is used for products like industrial grade power tools.

Cash-box design

To attain the highest strength, a "uni-body" fabrication process augments the material selection. The two halves of the cash-box are welded together, using an electromagnetic welding process. A composite bead of thermoplastic with particulate ferromagnetic filler (based on iron) is trapped between the

The Super Cash-Box

molded plastic halves. Placing the assembly in a dynamic magnetic field excites the iron particles in the bead. Hysteresis losses produce local heating of the bead and the plastics themselves, causing the cash-box halves to weld together. This design feature, along with many other cashbox design elements, is patent pending.

As you can see in the picture, curved surfaces protect cashbox edges and corners. There are smooth sides for orderly stacking on carts. There are no release latches to operate; features on the recession in the sides interact with over-rotating springs in the unit chassis to passively latch the cash-box. The grooves in the top of the cash-box mate with tabs on the acceptor assembly to provide a continuous bill path between the modules.

The internal stacker assembly slides in from the bottom of the cash-box. The stacker

drive gears are recessed below the surface of the cash-box. As you can see in the picture, the sides of the stacker assembly are made of clear Lexan. (You can see a $5 bill in the channel.)

When a bill is stacked, you can see the value area of the last bill stacked in the cash-box through the windows in the outer shell without removing or opening it. This feature should greatly expedite the resolution of customer bill disputes.

The cash-box is designed to survive drops from the top of collection carts (six feet) when either empty or full of money without damaging the reliability of the system.

With all this strength, the cash-box has ergonomic benefits as well. It takes only one hand to operate and weighs almost a pound and a half less than current cash-boxes.

Ease Of Use
The MEI CASHFLOW SC66 is designed for operators' ease of use. The front of the acceptor has a number of convenient features:

Acceptor Module
The acceptor unlatches from the chassis by pulling up on the release bar. The bill path opens by pulling forward on the cover on top of the acceptor. It snaps shut automatically when you close the acceptor halves. Bill entry guides for various OEM machines clip to the acceptor's upper housing; no tools are required for mounting.

If the bill entry guide (BEG) requires power for lights, there is a dedicated connector on the left side of the unit to power them.

On the right side of the acceptor there is a Universal Serial Bus (USB) connector to provide a convenient interface for support tools. The speed of USB greatly reduces the time to reprogram the unit's flash memory. If your gaming jurisdiction doesn't allow flash memory, the top cover of the acceptor easily detaches to reveal a PROM socket. The USB port will also be used for gathering audit and diagnostic data.

In the middle of the acceptor, there are three "traffic light" LEDs to provide floor diagnostic support. In normal operation, the green light on the left will be on continuously. The diagnostic system is simple:

A green light indicates that there is nothing wrong with the bill acceptor. However, there may be something else wrong with the machine (e.g. empty hopper) causing the bill acceptor to be disabled.

A yellow light indicates there is a problem that you can resolve right at the machine (e.g. jammed bill) without any parts.

A red light indicates there is an issue such that you will need a spare (e.g. hardware failure, full cash-box) in order to bring the unit back to service.

The problem areas are all shown by simple flash codes. The flash codes will be printed with explanations on wallet cards (i-cards).

Availability:
By the time of the G2E show, the MEI CASHFLOW SC66 should be approved for use in IGT Netplex machines in Nevada. Approvals for other manufacturers and jurisdictions will follow throughout the rest of the year.

Come see the MEI CASHFLOW SC66 at G2E booth #2611 or call MEI at 800-345-8215 or in Las Vegas at 702-597-4836. You can learn more about MEI, at www.meiglobal.com.

SC66 acceptor module

Atronic Announces "Inspiring Depth" At G2E
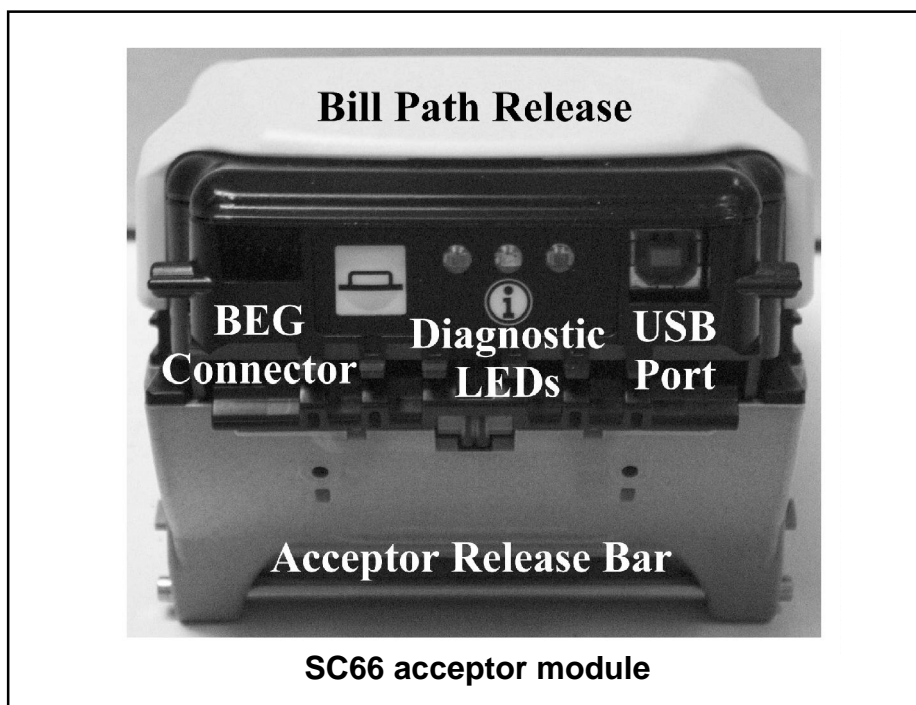
Atronic has announced the theme "inspiring depth" for the G2E trade show in Las Vegas. Atronic will feature its largest ever depth of products and new game themes anchored around the booth theme of "Atlantica."

Atronic brings its talent for successful, high quality products with interactive features to a multitude of new products and game themes in booth #544 at the G2E, which takes place September 17-19th in the Las Vegas Convention Center. Under the general theme "Inspiring depth," Atronic will present a range of new products including its first tower game Sphinx Magic, and its revolutionary new platform Hi(!)bility, as well as many new games including the featured, underwater treasure-themed Atlantica. In addition to the exciting product offering, Atronic will host its traditional happy hour in "Neptune's Grotto", where visitors can enjoy a cool drink and a chat in a relaxed atmosphere.

Atronic will feature several new products developed to meet the specific needs of its customers. Sphinx Magic, Atronic's first tower box game, was designed to attract a high level of play with its stunning display, featuring a unique multi-level progressive and interactive Magic Bonus Card feature, supplemented by the globally successful Sphinx brand.

Atronic will unveil it's highly anticipated, revolutionary new platform Hi(!)bility and new cabinet e-motion in a special area of the booth. Hi(!)bility and e-motion are an inspiring mix of the technology of the future combined with a self-merchandising, environment-creating package designed to enchant both existing and next generation players.
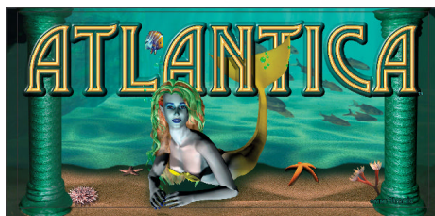
Hi(!)bility is ready to meet the current and imminent needs of operators with its future-thinking technology, and features remote game configurations, game download, fast game updates, and a high security operating system. Hi(!)bility's technological innovations, combined with the new cabinet e-motion's, ergonomic playfield and breathtaking design, create a richer environment on the casino floor.

Atronic will show a large selection of entertaining and exciting new Cashline games including Atlanica. Atlantica is distinguished by a luxurious underwater theme and inter-active bonus events, and features a spectacular deluxe topper to complete the themed package. Atronic will additionally exhibit new game themes Clowning Around, I.C. Cash, Beach Patrol, Wave Watchers, Dream Maker, Sign of the Zodiac, and Ghost Hunter. Successful, approved programs including Babooshka, Sphinx II, Typhoon Lagoon, and Beetlemania will also be shown in a variety of configurations and cabinets, including the AST, Atronic's innovative slant top, and the Titan, the world's first fully-functional oversized video slot. The game themes will be complimented by Atronic's flexible merchandising packages, further demonstrating Atronic's commitment to providing the widest variety of options to its customers.

For further information, contact:

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A Plumber's Guide to Fruit Machines - Part 6

By Gordon Lowe
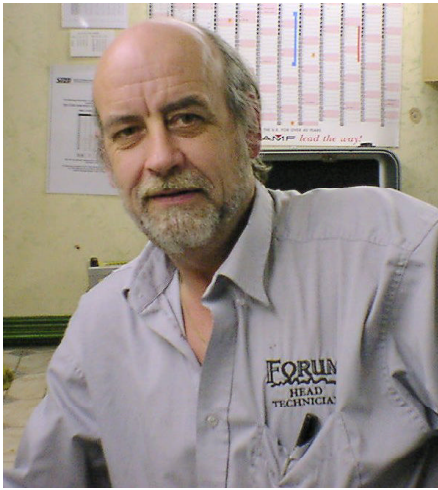
Section 3.
Coin Level Sensors

The correct operation of the coin level sensors is vital to ensure coins are paid out in the correct sequence and that tube starvation does not occur. One example would be a £1 tube sensor does not detect a full tube. The result would be that the next coin tube, 20p or 10p maybe, would payout all wins until the tube emptied.

Another example would be coins being re-routed to the cashbox because the MPU thinks the tube is full, the result of a jammed or faulty sensor.

There are two types of sensors: electronic and mechanical. By mechanical, I mean microswitches. No problem here, just replace it with the same type. Electronic, now here we have a wide selection of types operating on any-thing from actuator arms to optical sensors. First of all, identify if you have a problem with a sensor by entering the test routine for the particular machine you are working on. Every machine is different, although each manufacturer tends to adhere to its own sequences. Refer to the manual supplied with the machine. If you don't have one, give them a telephone call.

It is vital that, should a level sensor prove to be faulty, it is replaced with one of the same type. I make this point because of the Starpoint® electronic type (known as 2CLD). Here is a unit that appears on the outside to be all the same. They are not!

Internally, the circuit board is configured differently for each manufacturer of AWPs. In other words, JPM®, Ace®, Barcrest® and Electrocoin® are all different and are not interchangeable. Do so and the coin level sensing will not operate correctly. Each different type of unit is identified as follows:
Barcrest® = BCA
Ace® = FCA
Electrocoin® = BCB
JPM® = ECB

A brief description of this unit: An actuator arm detects whether or not a coin is present at that level. The arm then blocks the infrared light across an opto switch, which in turn provides information to the MPU. Take one apart. It's one of the best ways of learning and it is not difficult to put back together.

Other types include a horse-shoe shaped sensor where a beam is sensed through the coin tube and one which is a coil of wire fixed around the tube at the level where detection is required. Of the electronic types, I would say only the Starpoint(r) type is repairable, and this is usually the opto switch. However, the reliability of these electronic level sensors is high and faulty units are few and far between.

Level sensors, usually of the microswitch type, are often found fitted to hopper machines, more often as a safety precaution that will prevent the hopper from overflowing as the result of hopper float calculations computed by the MPU going adrift for some reason. Adjustment of this type of level sensor can be critical. If the microswitch is set too sensitive then even though the hopper may be nearly empty, the MPU may think it is too full and re-route any further coins inserted into the machine to the cashbox. Result: The hop-

per continually runs empty even though sufficient coins are found in the cashbox. (See also Section 2e)

Summary

Detecting the level of the coins when full or empty is vital to the correct operation of the host machine. With this in mind, I cannot over emphasize the importance of verifying that they are functioning as they should be, even down to the matter of ensuring secure fixture to the payout tube. All too often, machines will be found with the sensor not in line with the slot in the tube (where applicable) or a securing band that has perished and requires replacement.

Before suspecting faulty sensors or microswitches, check the electrical connections. In the case of microswitches, look for an actuator wire or arm that has been bent out of position, usually due to manhandling by a previous call to the machine.

More problems are caused by lack of attention, particularly when clearing coin jams, than any other reason. All that is required is to take your time with the job at hand. Do not be rushed and the machine will not need your attendance as frequently. This is what makes a good engineer.

- Gordon Lowe
glowe@slot-techs.com

SOT-23 Case Devices

By Herschel Peeler

C atch me once, shame on you. Catch me twice, shame on me.

In a previous article where we de-engineered a small microprocessor based circuit (see Swinging Jeannie, July, 2002), I mentioned that I ran across a part I couldn't identify. List this one under gripes if you want; surface mount parts that are too small to put a full part number on. "L01B" was all it said.

Okay, I admit it. I was caught with one foot on the platform and one foot on the train when the locomotive of technology ran away and made components microscopic. It caught me once. I'll try to avoid it a second time.

Attached to this e-mail is a list of ICs in SOT-23 size packages that are too small to put a standard part number on. The number does break down. I just had a hole in my experience where this was concerned. The one in question, "L01B" crosses to a National

Semiconductor "LP2980IM5-5.0". Try getting that on a SOT-23 case. Pulling my NSC data book down off the shelf, and spending a weekend with it, I now will not as easily be caught on the platform.

The list covers most ICs with similar cases. It's a standard Excel file, so you can edit and add to it as the locomotive of technology adds more devices. Other parts not listed are probably diodes, transis-tors, or even logic gates. Yes, there is a family of single-gate logic devices in SOT-23 cases. That's another week-end project.

Part number breakdown

The number is usually a three or four character number. The first character indicates what type of device it is. A - An Amplifier B - A Buffer (non-inverting amplifier) C - Voltage Comparator D - Driver H

SC-70, SC-70-5, SOT-23, SOT23-5, and SOT-23-6 cased components			
Marking	Equiv. p/n	Description	Case
A68A	LH6645MF	55 MHz, 2.7 V, RRIO amp	SOT-23-5
A69A	LH6647MF	55 MHz, 2.7 V, RRIO amp, w/ shutdown	SOT-23-5
T2B	LM20BIM7	2.4 V, 10 uA, Temperature sensor	SC70-5
T2C	LM20CIM7	2.4 V, 10 uA, Temperature sensor	SC70-5
TKLA	LM26CIM5-KLA	Thermostat, 23 deg C trip point	SOT-23
S15B	LM2765M6	Switched capacitor voltage converter	SOT-23-6
S16B	LM2766M6	Switched capacitor voltage converter	SOT-23-6
S17B	LM2767M5	Switched capacitor voltage converter	SOT-23-5
A63A	LM321MF	Low power op amp	SOT-23-5
D00A	LM3411AM5-3.3	Precision secondary regulator / Driver, 3.3 V	SOT-23-5
D01A	LM3411AM5-5.0	Precision secondary regulator / Driver, 5.0 V	SOT-23-5
D00B	LM3411M5-3.3	Precision secondary regulator / Driver, 3.3 V	SOT-23-5
D01B	LM3411M5-5.0	Precision secondary regulator / Driver, 5.0 V	SOT-23-5
L0C	LM3480IM3-12	Voltage regulator, 12 V, 100 mA	SOT-23
L0D	LM3480IM3-15	Voltage regulator, 15 V, 100 mA	SOT-23
L0A	LM3480IM3-3.3	Voltage regulator, 3.3 V, 100 mA	SOT-23
L0B	LM3480IM3-5.0	Voltage regulator, 5.0 V, 100 mA	SOT-23
L80B	LM3490IM5-12	Voltage regulator, 12 V, 100 mA, w/ On / Off input	SOT-23-5
L81B	LM3490IM5-15	Voltage regulator, 15 V, 100 mA, w/ On / Off input	SOT-23-5
L78B	LM3490IM5-3.3	Voltage regulator, 3.3 V, 100 mA, w/ On / Off input	SOT-23-5
L79B	LM3490IM5-5.0	Voltage regulator, 5.0 V, 100 mA, w/ On / Off input	SOT-23-5
D10B	LM3620M5-4	Lithium-Ion Battery Charge Controller, 4.2 V	SOT-23-5
D11B	LM3620M5-8	Lithium-Ion Battery Charge Controller, 8.4 V	SOT-23-5
R58B	LM3722EM5-2.32	Microprocessor Reset Circuit, 2.32 V, Low Rst	SOT-23-5
R53B	LM3724IM5-3.08	Microprocessor Reset Circuit, 3.08 V, Low OD	SOT-23-5
R55B	LM3724IM5-4.63	Microprocessor Reset Circuit, 4.63 V, Low OD	SOT-23-5
C397	LM397MF	Voltage comparator	SOT-23-5
R0A	LM4040AIM3-10.0	Voltage reference, 10.0 V, 0.1%	SOT-23
R2A	LM4040AIM3-2.5	Voltage reference, 2.5 V, 0.1%	SOT-23
L37B	LP2980IM5-4.7	Voltage reg. LDO, 4.7 V, 50 mA, w/ On / Off, 1.0%	SOT-23-5
L01B	LP2980IM5-5.0	Voltage reg. LDO, 5.0 V, 50 mA, w/ On / Off, 1.0%	SOT-23-5
L0CA	LP2981AIM5-2.5	Voltage reg. LDO, 2.5 V, 100 mA, w/ On / Off, 0.5%	SOT-23-5
LFAB	LP3988IMF-3.0	Volt reg., LDO, 3.0 V, 150 mA, "Power Good" output	SOT-23-5
(C397)	TL331	Voltage comparator	SOT-23-5

This is a sample of the database that you can use to identify SOT-23 devices. It has been posted to the Slot Tech ftp site. Visit the website at slot-techs.com for further details.

- Communications linear device L - Low dropout linear voltage regulator S - Switched capacitor voltage converter T - Temperature sensor Z - Audio

The following characters break down to specify a specific device, and usually reliability qualities. Each of the above listed families breaks it down differently. Get yourself some data books, folks.

I hope you find the reference handy to identify those tiny suckers. More info will follow, as I get time to document it. Let Randy know if you find such stuff useful. Maybe we can talk him into keeping updated file on his FTP site? These listings are 'living documents' that change constantly. The national Semiconductor list alone covers over 400 items, and is current to the 2002 data book (item number 400066 if you can get one from National).

National Semiconductor can be reached at www.national.com. It comes with a CD, that makes carrying the info to and from work a lot easier than carrying the book that's almost two inches thick and just covers "Analog and Interface Products."

Get one. Read it!

- Herschel Peeler
hpeeler@slot-techs.com

Slot Tech Magazine

A Look At Gaming Lighting from a Thin & Cool Perspective

By Wes Kelley & Mona Fechter
Durel Corporation

Gaming industry lighting is undergoing dramatic changes. Durel Corporation (Chandler, AZ), a fully integrated, high-volume manufacturer of electro-luminescent (EL) lamps and drivers, has been the #1 choice for worldwide applications such as cellular phones, watches, consumer electronics and automotive instrument clusters since 1988. Durel is now introducing specialized EL products into the casino/signage market, providing a complete systems-solution approach to backlighting gaming machines and signage applications. Durel's leading EL technology has been specially modified for these applications.

EL Benefits Durel electroluminescent lamps provide a high quality, thin, cool, and flexible alternative to traditional lighting systems. Unlike other lighting technologies, EL distributes light evenly over the entire surface, eliminating hot spots that degrade graphical details. Space is saved because the lamp package is less than 0.025" thick. Plus, energy-effi-

cient EL is a cool alternative to conventional hot bulbs. Durel lamps are delivered preassembled with wiring and standard connectors already in place, making installations quick and simple.

Gaming/Topper Applications Durel's newest product offerings are gaming machine lamps, manufactured for a variety of toppers, slot glass and gaming machine billboards. Durel's gaming/topper applications can be attached to the back of the graphic glass with flat c-channel clamps or adhesives, making these bright, space-savings lamps an attractive alternative to large fluorescent bulb cases.

Traditionally, toppers designed to attract the eye to new machines are unlit, or if lit, are thick and bulky. Durel's EL technology provides two-sided illuminated signs that are thin, lightweight, and can be easily moved from machine to machine by unplugging two wires and moving the lamp and driver. (To install a Durel EL topper, simply feed the cord down through the candle into the slot machine and plug it into the power supply (the driver). The driver is then simply plugged into a 110Vac/60Hz electric outlet.)

Power Supply Durel's EL drivers use patented technology to achieve extended life and luminance. Within a machine bank, a single unit can operate multiple lamps up to a maximum total lighted area of 20ft2. The drivers will formally be introduced into the marketplace in September, 2002.

Performance In addition to other features and benefits, EL lamps eliminate catastrophic failure. Over time, the luminance level of EL lamps gradually decline until they reach their minimum preferred luminance level ("Time to Half Luminance"), at which time new lamps can be installed. Replacement is safe, simple and fast. To achieve greatest performance, Durel's EL system is set at a specific luminance level and target life depending on the application. The drivers are programmed to increase voltage as the EL lamp's luminance declines, which will extend its Time to Half Luminance (THL) between 2,000 and 8,000 hours, depending on the starting luminance level. This facilitates scheduled maintenance at four- or six-month intervals, or with changes of the graphics package.

See Durel at the Global Gaming Show Exhibition, September 17-19, 2002, Las Vegas, NV. Booth #358 For more information about Durel's products, please contact Mona Fechter at 480-917-6260 Fax: 480-917-6049, email: mfechter@durel.com or visit our website at www.durel.com.

Durel Corporation is a joint venture between 3M Corporation, located in Minnesota, and Rogers Corporation, located in Connecticut. The company's product lines include coated phosphors, inks, custom electroluminescent lamps, EL drivers, design engineering applications, and consulting services.

Introduction to Electroluminescent Lamps

Electroluminescent (EL) lamps are essentially capacitors with one transparent electrode and a special phosphor material in the dielectric. When a strong AC voltage is applied, the phosphor glows.

The required AC voltage is typically not present in most systems and must be generated from a low voltage DC source. In the past this was done with a self-oscillating transformer circuit. These circuits are large, expensive, and they often produce audible noise. Durel solved these problems by developing a switch-mode inductor-based circuit integrated into a single chip. A family of chip inverters based on this type of circuit now exists.

Basic Circuit Operation

The chip inverter powers the EL lamp by repeatedly charging an inductor with current from a DC source and discharging into the capacitance of the EL lamp (Figure 1). With each cycle the voltage on the lamp is increased. After many cycles when the lamp voltage is sufficient the lamp is discharged and the polarity of the inductive charging is reversed. By this means a symmetric low frequency alternating voltage is developed at the lamp's input.

The inverter circuitry is divided into several parts: off-chip circuitry, on-chip logic and control, and on-chip high voltage output circuitry. The output circuitry handles the power through the inductor and delivers the high voltage to the lamp. The on-chip logic and control generates the lamp operating frequency (LF) as well as the inductor switching frequency (HF) and duty cycle (D). These signals are combined and buffered to drive the high voltage output circuitry. The off-chip circuitry provides a degree of flexibility so that HF and LF can be adjusted to accommodate various lamp sizes, system voltages, and brightness levels. Since a primary objective of these chips is to save space, off-chip components were kept to a minimum.

Charge Pumping Modes

Pulsed current mode

This is the preferred mode of operation. The current in the inductor is completely discharged into the lamp (load) at the end of each HF cycle. The inductor always starts with zero current at the beginning of each HF cycle. This mode requires sufficient time (td) to allow the inductor (L) to fully discharge into the capacitive lamp load (Z).

Continuous current mode

In this mode a new inductor charging cycle is started while current in the inductor is still
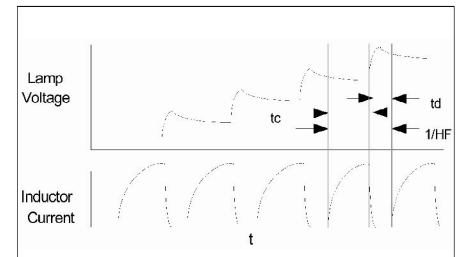
Figure 2: Pulsed Current Mode
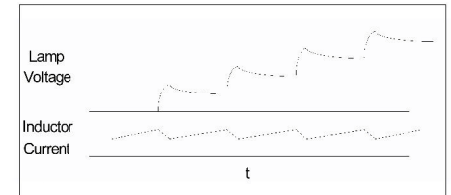
Figure 3: Continuous Current Mode
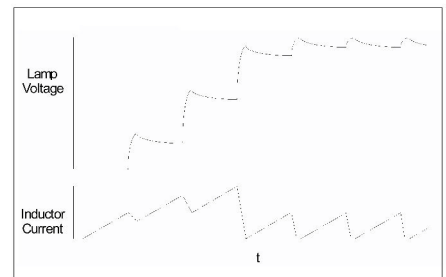
Figure 4: Mixed Mode

flowing into the lamp. Inductor current fluctuates but never reaches zero. Switching losses are higher and preventing inductor saturation becomes more difficult but higher power densities are possible.

Mixed mode

When lamp voltage is zero at the start of a lamp charging cycle it takes longer to discharge the inductor. There is not enough time to fully discharge the inductor so current builds from one HF cycle to the next. As voltage on the lamp builds, the inductor discharges more quickly so that inductor current starts to decline from cycle to cycle to the point where it reaches zero at the end of each HF cycle. It starts charging the lamp in continuous mode but finishes in pulsed mode. The lamp voltage builds much faster in the first phase, then flattens out in the pulsed phase.
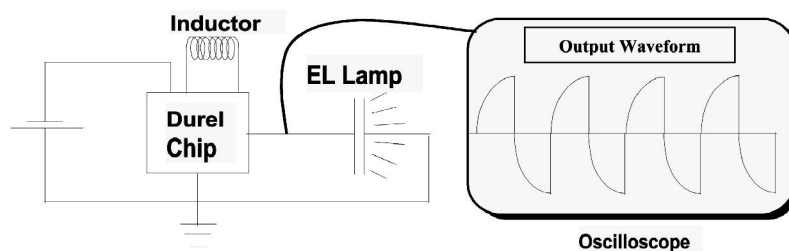
Figure 1: Inverter Operation Diagram

Introduction to Digital Electronics
Part2

Remember when I mentioned last month that it's easier for an IC to go low than it is to provide a high (recall the "totem-pole")? There is another kind of AND gate. This one includes the NOT function we saw in the inverter. It's called a "NAND" gate. NAND stands for "NOT AND." It's like an AND gate followed by an inverter. Take a look at the 7400 integrated circuit. It looks like the AND gate but it has the bubble on the end. Look at the truth table for the NAND gate. It's exactly the same as the AND gate, but the output is reversed. In the NAND gate, both inputs must be high in order to get a low out.

The 5 basic types of gates

There are some other types of gates as well. One is called an "OR" gate. If one or the other or both inputs are high, the output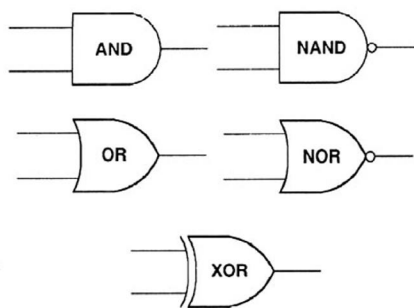 will be high. The active low version of the OR gate is called the "NOR" gate. If one or the other or both inputs are high, the output will be low.

Another type of OR gate is called the "exclusive OR."

You'll see it abbreviated XOR. If one or the other input is high, the output will be high but not if both inputs are high. If both inputs are high, the output is low. An example of the XOR in action might be a composite sync generator where the vertical sync is connected to one of the XOR inputs and the horizontal sync is connected to the other. The output of the XOR gate is composite sync.

When you are thinking about logic functions, don't get hung up on the name of the gate. To illustrate my point, let's go back to the AND gate. When one input AND the other are both high, you'll get a high out. That's logical, huh? After all, it is called LOGIC, isn't it?

But think about it like this: imagine both inputs as being high. If both the inputs are high, the output of the gate is high, right? But if one input OR the other input goes low, the output will be low, won't it? In this case, we are using the AND gate to perform a kind of OR function, aren't we? This is a perfectly acceptable way to think of the AND gate. It's called "negative logic."

It's the same with the OR gate. The truth table states that if one input OR the other input is high, the output will be high. In terms of negative logic, if one input and the other input are both low, the output will be low.

How does this affect us as technicians? Not much as far as testing the individual gate is concerned. That remains the same no matter what. It does go toward understanding how that particular device is being used within the system.

By combining gates into more complex circuits, it's possible to design a digital circuit that will do almost anything. In fact, just about all of the digital integrated circuits in use today are simply combinations of the basic gates we have already examined.

As we have seen, the gates can only respond to a certain set of input conditions. When the input conditions are met, the output responds accordingly. But the gates function only as transient circuits;

The XOR (exclusive OR) gate in action. With vertical sync at input A and horizontal sync at input B. The output Y is composite sync.

7400
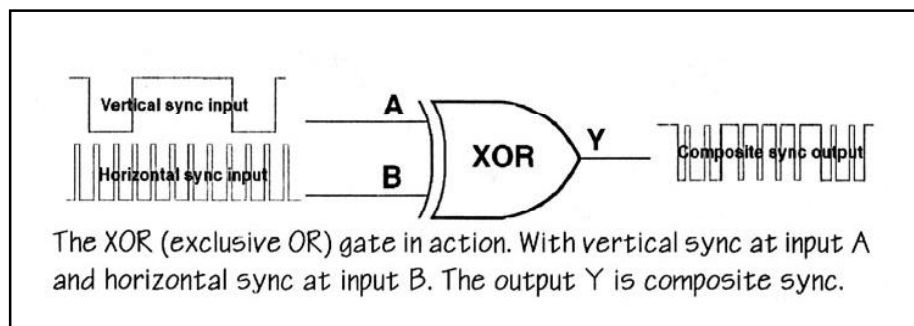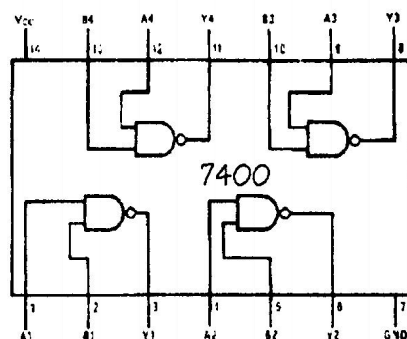
Inputs		Outputs
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

H = High Logic Level
L = Low Logic Level

7402
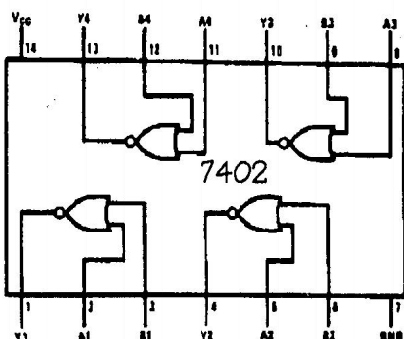
Inputs		Output
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

7404
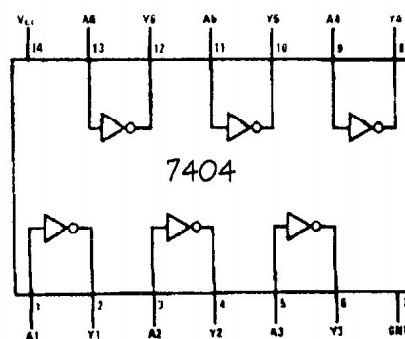
Input	Output
A	Y
L	H
H	L

7408

Inputs		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

7410
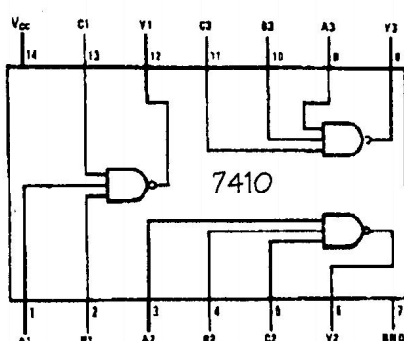
Inputs			Output
A	B	C	Y
X	X	L	H
X	L	X	H
L	X	X	H
H	H	H	L

H = High Logic Level
L = Low Logic Level
X = Either Low or High Logic Level

7420
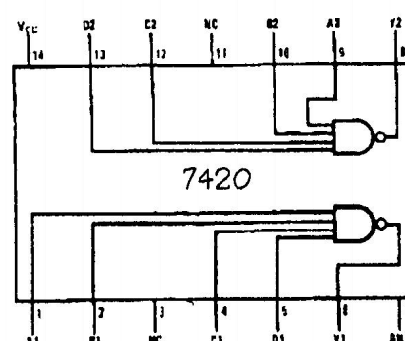
Inputs				Output
A	B	C	D	Y
X	X	X	L	H
X	X	L	X	H
X	L	X	X	H
L	X	X	X	H
H	H	H	H	L

7427
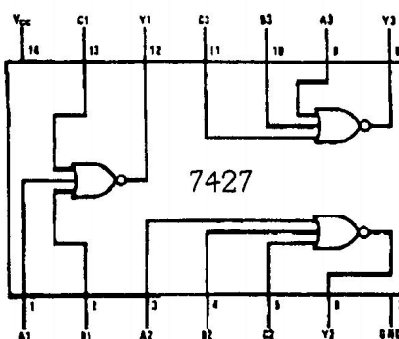
Inputs			Output
A	B	C	Y
L	L	L	H
X	X	H	L
X	H	X	L
H	X	X	L

7430
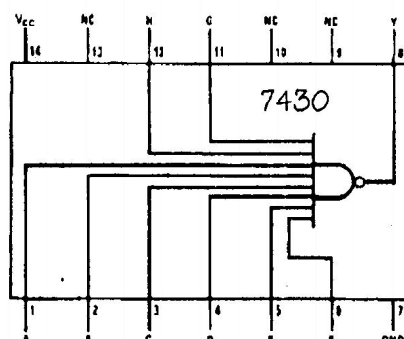
Inputs	Output
A thru H	Y
All inputs H	L
One or more input L	H

7432
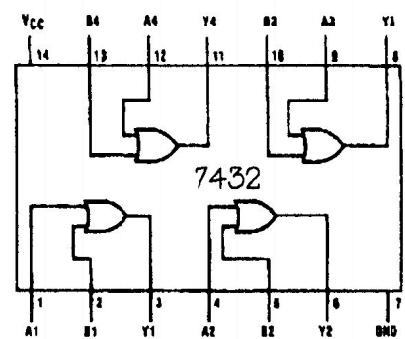
Inputs		Output
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	H

A sample of TTL inverters and gates with their truth tables

they cannot store any information.

A flip-flop is a type of circuit that can store a single bit of data. There are several different types of flip-flops. The simplest is known as an RS flip-flop. The RS stands for "RESET/SET."

We can make an RS flip-flop with two NAND gates connected as shown in figure 1. R and S are the two inputs to the flip-flop. The flip-flop also has two outputs. Both are labeled with the letter "Q" but one has a bar over the top of it. The bar indicates a complimentary function and is read "NOT Q" or "Q NOT." That is to say, if the Q output is high, the Q NOT output will be low and vice-versa. Integrated circuits will often sport complimentary outputs if for no other reason than that the extra pins are available in the IC package so they might as well be used for something.

When inputs R and S are both high, the flip-flop is in a steady state. For the sake of discussion, let's say that the flip-flop is "set" with its Q output high. Naturally, the Q NOT output will be low.

If the R input is momentarily brought low, the Q output will go low. The flip-flop is now in its "reset" condition and will stay that way, even when the R input goes high again. Only a brief pulse is needed to reset the flip-flop. Subsequent toggling of the R input will have no effect on the outputs. Once the flip-flop is in the reset condition it will stay that way; storing its single "bit" of data.

In order to "set" the flip-flop, the S input is momentarily brought low. This brings the Q output high again. Again, subsequent high/low transitions on the S input will have no effect on the outputs. Once the flip-flop is set, it's set.

Bringing both inputs low is a disallowed condition for the RS flip-flop, since this would force both outputs high simultaneously.

You can easily make an RS flip-flop yourself out of a single 7400 IC. In fact, since the 7400 is a "quad" NAND gate, you can make two RS flip-flops out of one IC!

Can you imagine where we might use an RS flip-flop? Think about a circuit where you want to flash a lightbulb or LED. When the game's CPU wants to turn the lamp on, it might send out a momentary pulse that "sets" an RS flip-flop, activating the lamp or LED. The lamp continues to glow until the CPU sends a low going pulse that "resets" the

flip-flop and shuts off the lamp. This is not how it's done in the real world but I couldn't think of a better example, so sue me.

Clocked Logic

With the RS flip-flop, the outputs change as soon as the appropriate input conditions are met. This is known as "asynchronous" operation. However, in a computer system we often need things to happen simultaneously or sequentially. A computer "clock" is used to make sure that things happen exactly when they're supposed to. An integrated circuit that uses a clock signal to initiate an function is known as having a "synchronous" operation. This is also known as "clocked logic."

A good example of clocked logic is the "type D" flip-flop. The "D" stands for data. The most common type D flip-flop is the 7474. This is a "Dual D Flip-Flop" with two completely independent devices in one, fourteen pin package.

As with the RS flip-flop, the type D flip-flop has complimentary outputs. Remember the little bubble on the end of the inverter, NOR and NAND gates? Here we see it again on the Q NOT output of the flip-flop. Remember, the bubble means "active low."

The remaining four connections are all inputs to the flip-flop. "D" is the "data" input of the flip-flop; "C" stands for "clock." The other two inputs are "set" and "clear."

Here's how the type D flip-flop works:

The most basic of all flip-flops is the RS flip-flop. RS stands for "reset/set."
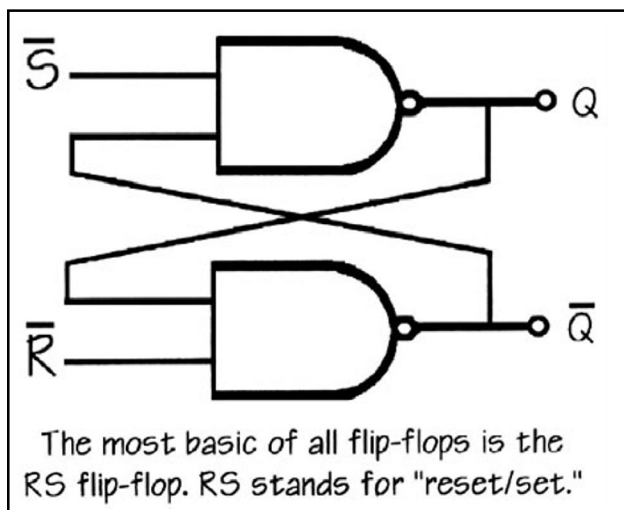
When the flip-flop is "set," the Q output is high. The Q NOT output is, of course, low. If the data input is brought low, the outputs do not immediately change state. The logic low at the data input is transferred to the Q output only when the flip-flop receives a clock pulse. Specifically, the data is transferred on the positive edge of the clock pulse, when the clock pulse makes a low to high transition. Once the clock pulse is high, the data input is "locked-out" and any changes are ignored. Any information present at the D input will not be transferred until the next rising edge of the clock pulse input.

If the condition of the D input remains low, subsequent clocking of the flip-flop will not produce any change in state at the outputs. The flip-flop will remain "reset" with the Q output low. If the D input is brought high, the Q output will go high with the next low-to-high transition of the clock pulse. In other words, any change in the outputs is "synchronized" with the clock pulse. This is reflected in the truth table.

So, what about the other two inputs? Notice that they both have the bubble on them (active low, remember?) The "set" input does just what the name implies. A logic low on the set input "sets" the flip-flop, making Q high. A logic low on the "clear" input has just the opposite effect, making the Q output a logic low. Both the set and clear are asynchronous inputs that are independent of the clock and data inputs. When set goes low, Q goes high immediately, regardless of what is happening at the D and clock inputs. When clear goes low, Q follows no matter what going on with the clock and data inputs. A simultaneous low on both set and clear will force both outputs high. In this case, the outputs are obviously not complimentary.

The logic diagram for the type D flip-flop is shown in figure 3. You will not need to follow this schematic in the course of your normal work as a technician but it's interesting to see how the basic gates are combined to make a new type of IC.

Here's a neat way to hook up a type D flip-flop. Connect the Q NOT output to the D input. What will this do? Let's think about it. Let's start with the flip-flop "set". The Q output is high and the Q NOT output is low. This puts a logic low on the D input, doesn't it? What will happen when the next clock pulse occurs? The low at the D input will be transferred to the Q output and Q NOT will go high. Since the D input is connected to the Q NOT output, the D input is also high now, isn't it? What happens at the next clock pulse? The flip-flop changes state again doesn't it? Each subsequent clock pulse "flips" or "flops"

DUAL D-TYPE POSITIVE EDGE-TRIGGERED FLIP-FLOP

The 7474 dual edge-triggered flip-flop utilizes Schottky TTL circuitry to produce high speed D-type flip-flops. Each flip-flop has individual clear and set inputs, and also complementary Q and Q outputs.

Information at input D is transferred to the Q output on the positive-going edge of the clock pulse. Clock triggering occurs at a voltage level of the clock pulse and is not directly related to the transition time of the positive-going pulse. When the clock input is at either the HIGH or the LOW level, the D input signal has no effect.

LOGIC DIAGRAM (Each Flip-Flop)

SET ($\overline{S_D}$) 4 (10)
CLEAR ($\overline{CD}$) 1 (13)
CLOCK 3 (11)
D 2 (12)
Q 5 (9)
$\overline{Q}$ 6 (8)
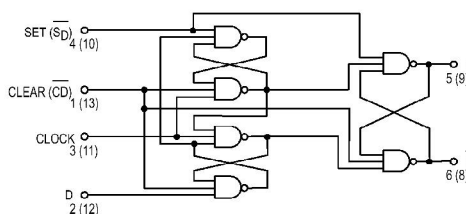
MODE SELECT — TRUTH TABLE

OPERATING MODE	INPUTS			OUTPUTS	
	$\overline{S_D}$	$\overline{S_D}$	D	Q	$\overline{Q}$
Set	L	H	X	H	L
Reset (Clear)	H	L	X	L	H
*Undetermined	L	L	X	H	H
Load "1" (Set)	H	H	h	H	L
Load "0" (Reset)	H	H	l	L	H

* Both outputs will be HIGH while both S_D and C_D are LOW, but the output states are unpredictable if S_D and C_D go HIGH simultaneously. If the levels at the set and clear are near V_{IL} maximum then we cannot guarantee to meet the minimum level for V_{OH}.

H, h = HIGH Voltage Level
L, l = LOW Voltage Level
X = Don't Care
l, h (q) = Lower case letters indicate the state of the referenced input (or output) one set-up time prior to the HIGH to LOW clock transition.

7474 FLIP-FLOP

DUAL D-TYPE POSITIVE EDGE-TRIGGERED FLIP-FLOP

J SUFFIX
CERAMIC
CASE 632-08
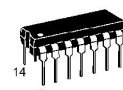
N SUFFIX
PLASTIC
CASE 646-06

D SUFFIX
SOIC
CASE 751A-02

ORDERING INFORMATION

SN54LSXXJ	Ceramic
SN74LSXXN	Plastic
SN74LSXXD	SOIC

LOGIC SYMBOL
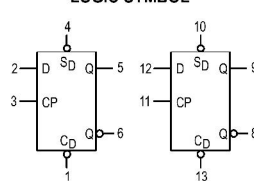
V_{CC} = PIN 14
GND = PIN 7

the circuit to the opposite condition. This is called "toggling."

Since it takes two clock pulses to cycle the toggle circuit from one state to another and back again, a toggle circuit is very useful for dividing the frequency of a signal. For example, if a clock pulse of 1000 Hertz (1000 cycles per second) is applied to the circuit, the outputs will change at a rate of 500 Hertz. It's not unusual to see this circuit in videogames where a crystal-controlled clock frequency of more than 14 megahertz (14 million cycles per second) is divided in half by a type D flip-flop connected in a toggle circuit.

JK Flip-Flop

Another popular type of flip-flop is the type JK flip-flop. A common part is a 74107. The JK flip-flop works in much the same way as a type D flip-flop with a few enhancements and minor changes in the way it operates.

Like the type D flip-flop, the JK flip-flop has two, complimentary outputs, Q and Q NOT. It has 4 inputs as well. The "clear" input works the same way as it did in the type D flip-flop. The clock input works in a slightly different way, transferring data to the outputs on the falling edge of the clock pulse rather than the low to high transition of the clock as it did in the type D flip-flop.

The truth table for the JK flip-flop shows you the difference between the two. When J and K are both low, the clock pulse has no effect on the outputs.

When J and K are set to opposite states, the state of the inputs is transferred directly to the associated outputs. If J is high and K is low, clocking the flip-flop makes Q high and Q NOT low. Conversely, a low on J and a high on K will cause the Q output to go low and the Q NOT output to go high following the falling or negative going edge of the clock pulse.

Making both J and K inputs high puts the JK flip-flop into the "toggle" mode. When a clock pulse is applied, the outputs change to the opposite state from what they were before the clock pulse. In other words, the first clock pulse "flips" the device while the following pulse "flops" it.

Next month we'll take a look at digital troubleshooting, and I'll show you a way to find bad ICs using just a battery, two wires, and a finger!

74107
Functional diagram.

FUNCTION TABLE **74107**

OPERATING MODE	INPUTS				OUTPUTS	
	n$\overline{R}$	n$\overline{CP}$	J	K	Q	$\overline{Q}$
asynchronous reset	L	X	X	X	L	H
toggle	H	↓	h	h	$\overline{q}$	q
load "0" (reset)	H	↓	l	h	L	H
load "1" (set)	H	↓	h	l	H	L
hold "no change"	H	↓	l	l	q	$\overline{q}$

Note

1. H = HIGH voltage level
    h = HIGH voltage level one set-up time prior to the HIGH-to-LOW CP transition
    L = LOW voltage level
    l = LOW voltage level one set-up time prior to the HIGH-to-LOW CP transition
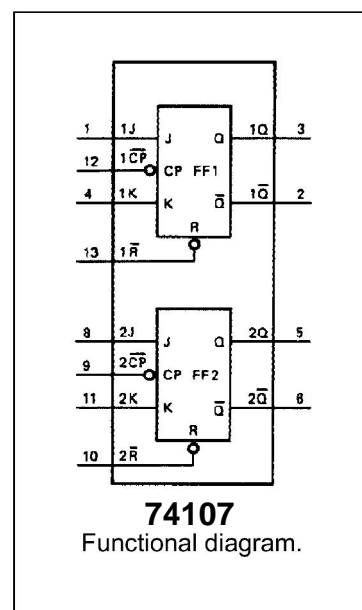   q = lower case letters indicate the state of the referenced output one set-up time prior to the HIGH-to-LOW CP transition
    X = don't care
    ↓ = HIGH-to-LOW CP transition

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Tuesday, October 22nd, 2002

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

1:15pm - 3:15pm
Asahi Seiko - Hopper troubleshooting and repair

3:30pm - 5:30pm
3M Touchsystems - Touchscreen Technology

Thursday, August 15th, 2002
Wednesday, October 23rd, 2002

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

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

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

Friday, August 16th, 2002
Thursday, October 24th, 2002

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

1:15pm - 3:15pm
Sencore - Monitor Troubleshooting and Repair - Using sophisticated test equipment to speed through monitor repairs

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JCM Bill Validator Troubleshooting and Repair

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