SLOT TECH
MAGAZINE

Slot Machine Technology for the International Gaming Industry

Math Mayhem! - Aristocrat Vs. IGT
Quick and Simple Repairs # 10
IGT Reel Touch Spinning Reel games
The Printed Circuit Board of Executives
Understanding Video Reels - Part 6 of 6
Slot Tech Training at Thunder Valley Casino

$10.00

February 2006

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Slot Tech Editorial

When I talk to slot techs around the world, I always make a point of asking them (you) if they (you) are satisfied with the content of Slot Tech Magazine. I sort of assume that they (you) are as many of them (you) have been subscribers for a number of years (our first edition was published in 2001). I also ask you what you'd like to see in future issues and some of you (okay, one guy really) mentioned that he'd like to see an overview of the IGT processor board itself. This guy is al-

ready well-versed in the peripheral devices such as bill validators and ticket printers and the now all but extinct coin hoppers and coin validators. He asked if we could present a general, first look at the CPU itself.

In another one of those weird bits of serendipity or synchronicity or whatever you want to call it, I had in my possession, just such an article, carefully wrought by Slot Tech Magazine's own Herschel Peeler. Herschel loves this kind of stuff. He sort of lives for the bench and its detailed, component-level repairs. I had been saving this article for a while, trying to figure out a way to get around the fact that the article makes direct reference to ten pages of schematic drawings and that there just isn't room in the magazine for them. In the end, there is only one way to do this and that is for you to download the schematic diagrams yourself. The URL is given in the article. It is very likely that you already have this package of schematics at your casino anyway. Herschel's article, "IGT Reel Touch Spinning Reel Games," begins on page six.

On the other hand, if you're looking for a system-wide overview of a slot machine and a description of not just the CPU but all of the printed circuit boards that go into it, Atronic's Michael Brennan takes us through the entire system in his column, this month entitled "The Printed Circuit Board of Executives" beginning on page 14.

This issue marks the conclusion of John Wilson's six part presentation on video reel slot math. There is also a bit of slot math in the gaming news that ties in nicely with this series. On December 14th, 2005, Aristocrat Technologies, Inc. filed a patent infringement lawsuit against IGT. Aristocrat alleges that IGT infringed on their Reel Power® patent by creating IGT's MultiWayTM slot machines. Slot Tech Magazine takes an in-depth look at the real (reel?) meat and potatoes of the slot math that is at the heart of the dispute, beginning on page 32.

I am happy to announce that our popular TechFest program has been augmented by a casino management seminar program that brings to the business side of things, the same dynamic, fast-paced learning experience that TechFest presents on the technical side. TechFest 13 is now just one of the training programs being offered at the inauguration of CasinoFest, to be held at Mystic Lake Casino, May 16 – 18, 2006. The three-day program includes a variety of engaging and educational programs for the management side of the casino operation. The CasinoFest is hosted by Casino Enterprise Management Magazine (try saying THAT three times, quickly). For more information, visit their website casinoenterprisemanagement.com.

That's all for now. See you at the casino.

Randy Fromm

IGT Reel Touch
Spinning Reel games

By Herschel Peeler

These are the current line of 80960 S-2000 series games from IGT. They are basically an S-2000 with more bells and whistles added. The processor is the same functionally. If you understand how the Reel Touch game works, older S-2000 games are a subset of these functions. The schematic diagram for the board under discussion is available at http://tinyurl.com/cdtu7 It's Drawing 75510514

Page 1 of 10

Here we have an overall block diagram of the processor board layout and how the various pages connect together.

Page 2 of 10

In the middle of this drawing we have the 80960 microprocessor that IGT uses in this series of games. This chip and most of the circuitry on the following pages is the same for all reel and video games in the 80960 series, which are all IGT games we currently have on the floor. The 80960 is a 16-bit processor. That is, we have 16 Data bits in the CPU's data bus. We have 32 Address lines, giving us, literally, gigabytes of addressing capability to work with. This is much more than we will need and our Memory Map has many unused areas we simply don't use. To keep the pin count on the chip down, Intel has multiplexed the Data Lines onto the Lower 16 Address lines. You will note the names of the lower 16 Address line reflect this. They are named D0 and AD1 to AD15. Since we reference memory a word (two bytes) at a time, we do not need Address bit 0.

One line is "ALE", Address Latch Enable. Early in the machine cycle, the processor put out the address on the ADx lines and provides a timing strobe, ALE. External latches on the board latch the lower 16 address bits. From then on, the lower 16 lines are data bus. Most of the other Control Lines are familiar functions we will cover as we go through the schematic of the CPU and MPU.

U42, 74HC138 We decode the upper address lines to get eight banks of our Address Map for various operations.

0x0000 0000 – This is our EPROM Select range. Intel is consistent. EPROM stuff has to be on Page 0. 0x0800 0000 – Flash Memory Select range. 0x1000 0000 – RAM Select range. 0x1800 0000 - Reel operations on page 6 of these schematics. 0x2000 0000 – Slave Monitor Select (for the added LCD video that defines this game as a Reel Touch or Vision model game. 0x2800 0000 – IO Select. Our Memory Mapped I/O. 0x3000 0000 – PA Select. 0x3800 0000 – MEZZ, our Mezzanine Board Select.
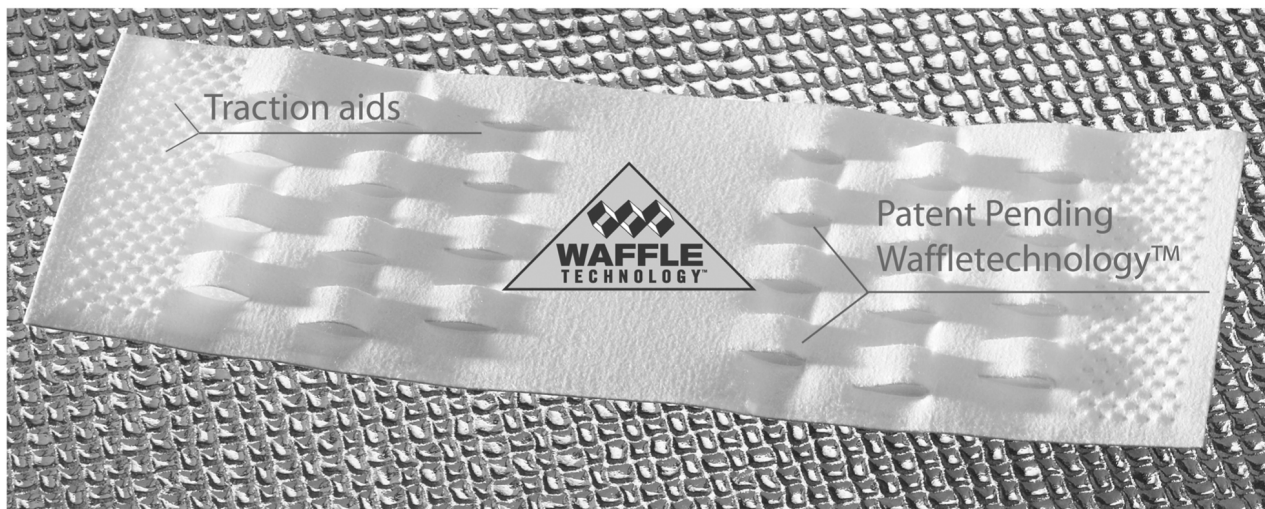
U52, a Programmable Logic Array IGT has integrated a handful of chips into one programmable logic circuit. Coming out of this chip we have select lines for many other functions. These are a high point of failure in many games. If a specific function is not working or functions are being confused, this is a good chip to swap out first. We have a multitude of fast changing signals concen-

trated in a very densely integrated chip. This is a bad combination of events and makes this a point of common failure.

SYS CLK – System Clock output.

IOT SEL\ - To U13 on Page 3.

WR0\ - SRAM Write Enable 0 to Page 3 and eventually to page 10.

RESET – This is the Reset to the board circuits.

RD\ - Our Read* strobe we are already familiar with.

IOWR\ - I/O Write* strobe.

IORD\ - I/O Read* strobe.

FAILURE – Lights DS1 on CPU Failure Indicator, Page 5

S ALE – System Address Latch Enable WR1\ - SRAM Write Enable 1 to Page 3 and eventually to page 10.

CLK – A Clock Output

Other inputs:

SENRDY – SENET Ready, see page 5.

MEZRDY\ - Mezzanine Ready

U30 and U31 Address Latch These are two 8-bit latches that latch the Data Bus at ALE and, as mentioned earlier, catch the lower 16 Address lines coming out of the multiplexed ADxx lines.

U22, PD Bi-directional data port

This an 8-bit bi-directional data port for data going to and from 8-bit peripheral devices. QUARTs, Digital Pot, etc. Since this is an 8-bit function only D0 through D7 are used. The 74AC245 is a bi-directional 8-bit buffer. It is enabled by an output of U52 for solely this purpose. The direction (Input or Output) is determined by the signal on the DIR line that comes from the 80960 "DT/ R\" line. This is High when transmitting data and Low when Receiving data.

U32 and the circuitry around it is our timing generator that sets the speed of operation for most functions on the board. Certain other minor functions have their own timing signals, but this one covers most board operations in general. Jumpers on the board set specific frequencies. I confess I have not made a study of which boards use what frequencies.

Page 3 of 10

U21 is our Main EPROM. In here we expect to find POST, Diagnostics and Bookkeeping routines and basic system operations that are not game specific. This is a 16-bit wide EPROM, and is the only 40-pin EPROM in the game. All other EPROMs are 8-bits wide and are smaller in pin count. U9A is half of a 74HC139 that is simply an-

other decoder that decodes Address lines A21 and A22 and is enabled at "EPROM Select\" time to give "Boot Select\" that enables U21.

If you reference the PSR (Program Summary Report) it describes various things that happen in the game in general operation. This is where the routines that control these operations exist.

U14 RTC

Oddly enough, within this address range they have also put the Epson RTC (Real Time Clock) chip. This may be as an afterthought to the game design. I can't think of a good reason to put it here. When you read or set the clock and calendar in the game, this is where you get or put this information. If your game has a problem keeping time or calendar information, this is the first chip to change.
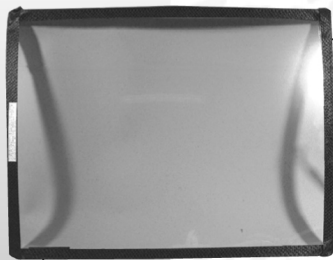
U13 is yet another Decoder to further select sub-ranges within the range of "IOT Select\." This gives us the Address of the following functions:

0x2800 0000 – MEZ2 Select. A secondary Mezzanine Select line.

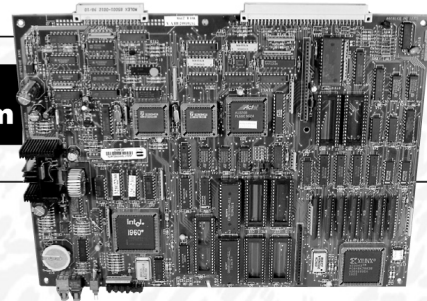0x2801 0000 – QRT1 Select. A Select line for one of our QUART chips.

0x2802 0000 – SENET Select which selects the SENET chip.
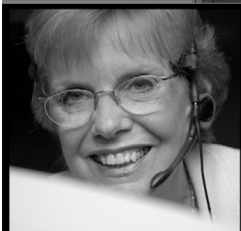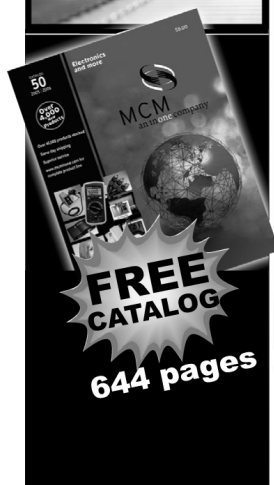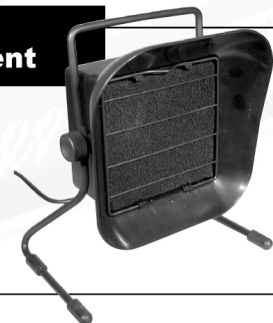
0x2803 0000 – Watchdog Select. Goes to U4 on Page 9.

0x2804 0000 – QRT2 Select. . A Select line for the other QUART chip.

0x2805 0000 – Sound Select to select our Sound chip (U66 on page 4).

0x2806 0000 – (not used)

0x2807 0000 – OUT Select. Goes to Page 4, and the Digital Pot port, among other places.

The area above U13 is a summary of the circuitry on page 10 and just gives us a convenient reference to signals going and coming from stuff on that page.

Page 4 of 10

This page has our two QUARTs (Quad Universal Asynchronous Receiver and Transmitter). We have eight basic serial I/O channels.

U68, QUART #1
Channel A – Will eventually become our RS-485 port.
Channel B – Touch Screen
Channel C – Secondary Data Collection Channel D – Onboard Fiber Optics port

U69 QUART #2
Channel A – NETPLEX
Channel B – Spare Fiber Optics
Channel C – Progressive System
Channel D – IGT Data Collection System

U66 Audio

U66 is our Digital to Analog converter. The CPU sends out digital information. This chip converts it to an analog signal to become sound. Following the RO and MO outputs to U720A this is where the board sound mixes with sound from the Multimedia board so we can add sounds generated off the board to the games sound system. U71 is our digitally controlled volume control. This nothing more than a digital potentiometer which would only be new to us old folks who remember turning a knob to change our volume. Such things are digital these days and this is how they do it. U85 is our power audio amplifier that drives the speaker. Mono only. How boring. U78 is a voltage regulator that provides a quiet source of power to our audio circuits.

U75

This latch is where the CPU controls the Digital Pot used to control the volume on the audio channel.

Page 5 of 10

U56, SENET Controller

U56 is a chip unique to IGT games. It is a ninth serial port to the game. Working with U62 and U67, this is a Synchronous Serial port that goes to all SENET devices in the game. It is, in itself, an embedded microcomputer that handles this specific function. Any SENET specific problems on a board can

likely be found in this specific area.

LEDs

The six LEDs visible on the front of the MPU are primarily defined by software. DS1 is a general CPU failure indicator. If a problem exists and is recognized by the CPU, but the nature of the problem prohibits an on screen message we can at least blink a light to let the tech know the CPU has a problem.

DS6 blinks as the system is communicating with the Data Collection System. The meaning of the other LEDs can probably be found in the PSR (Program Summary Report) for the specific Main EPROM version you have.

Page 6 of 10

Page 6 is basic reel control latches for (U700 to U704) and Reel Home position sensors (U707 and U708). If one specific reel is not moving properly we can look at the driver for that specific reel. These are not the actual Reel Motor Drivers, but the interface between the reel motor drivers and the CPU.

Reel 1 – U700
Reel 2 – U702
Reel 3 – U704
Reel 4 – U701
Reel 5 – U703

If the game is reporting a reel to not be moving correctly the problem is likely to be in U708, and less likely to be in U707.

These are the MOSFETs that actually drive the Reel Motors and are the more likely point of failure than the latches on page 6.

Reel 1 – Q700, Q701, U709 and U710, or the associated diodes.
Reel 2 – Q702, Q703, U711 and U712, or the associated diodes.
Reel 3 – Q704, Q705, U713 and U714, or the associated diodes.
Reel 4 – Q706, Q707, U715 and U716, or the associated diodes.
Reel 5 – Q708, Q709, U717 and U718, or the associated diodes.

Page 8 of 10

This circuit is called the Tell-Tale Circuit and is powered independently by a NiCad Battery even when the game is turned off. It notes when doors have been opened while the game was turned off. I'm sure, if you thought about it for awhile, you could imagine the intended use for this circuit. Many jurisdictions do not use this circuit. The NiCad battery and these chips may not even be on the board. Some jurisdictions probably wish they did.

Page 9 of 10

Page 8 is Tell-Tale stuff that deals with security circuits that note doors opening during the time when power is off. Since this really doesn't deal much with CPU and MPU stuff, we will only mention it here in passing but spend no time on it. This is worth an article in itself.

Page 9 has a number of functions on it that are not associated with one another. U6 is our +5 Volt Regulator. It takes the system +13 Volts and drops it down to +5 Volts for most of the logic things we have covered. Our two Fiber Optic ports are shown here. The only thing worth noting here is that the fiber optics are disabled at U7 during Reset. U15 is our Battery Controller chip that senses our battery voltage and tells us when our battery is low. We have two battery options. BT1 is a non-rechargeable Lithium battery (most often used). BT2 is a NiCad battery more often associated with the Tell-Tale circuit on page 8. Being NiCad, we need associated circuits of U79 and U84 to charge it. U4 is our System Reset chip.

Page 10 of 10

Here we finally have our other memory chips. Since our RAM and EPROMs come in 8-bit data size (byte wide), we have an upper and lower byte for each Game, SRAM and REEL functions. Our Game EPROMs are unique to a game theme and may be EPROM or Flash. The SRAM (Static RAM) is our data RAM for most operations. The Reel EPROMs may actually be EPROM or Flash. In all cases these chips have options in size. Jumpers on the board should be changed when changing chips if warranted. Pay attention to these when you are converting a game.

Game chips establish basic game play. Reel EPROMs establish an association between the random numbers that make up a win and what award should be associated with each combination of random numbers. Note: Game and Reel chips are Random Number related. There is only a loose association between these numbers and the symbols. It is quite common to have one set of chips be used for different game themes. It is these chips that are described in the PAR sheet.

J5, J6 and seldom J7
These are the three SIMM sockets on the game for added memory capacity. J5 is more likely to be Flash Memory. J6 is SRAM, J7 is Expanded SRAM. The part list includes about a half dozen options for these SIMM sockets. I have no handy reference for which SIMMs go with which games themes.

- Herschel Peeler
hpeeler@slot-techs.com

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Taking Care of Business

The Printed Circuit Board of Executives

By Michael Brennan

Our Chairman of the Board is the main board, the smartest, sharpest, most dominant one of the bunch. He's not "Old Blue Eyes," but instead is done up in the comforting color of circuit board green. The main board governs most of the software and controls all the main functionalities of the machine. Sitting in the head chair of the logic box, the Atronic electronic CEO is equipped with five EPROM assistants and one microcontroller.

Two of the main board EPROMs (U5 and U6) contain the Base software. The base software includes the operating system for all security relevant game routines. Base software also contains the commboard and multimedia board interface, the money manager, a statistic module, the initial setup and service menus, an exception handler, an event log, a random number generator and the jurisdictional configuration.

Two other EPROMs (U7 and U8) on the main board contain the Game software. These two chips provide the game with the modular

When discussing printed circuit boards in-depth, when delving into over fifteen hundred words relaying the specifics of mother boards, main boards and hopper boards, it's easy to become, well, bored.

But at Atronic, we have tried to give some personality to the twelve most vital circuit boards in our e-motion™cabinet. These one dozen pcbs compose the Atronic Printed Circuit Board of Executives and each one attends an eternal board meeting, diligently performing their assigned duties. So, without further ado, we introduce to you the twelve members of the Circuit Board of Executives.

The Chief Executive Officer

Circuit Boards in the Atronic Logic Box
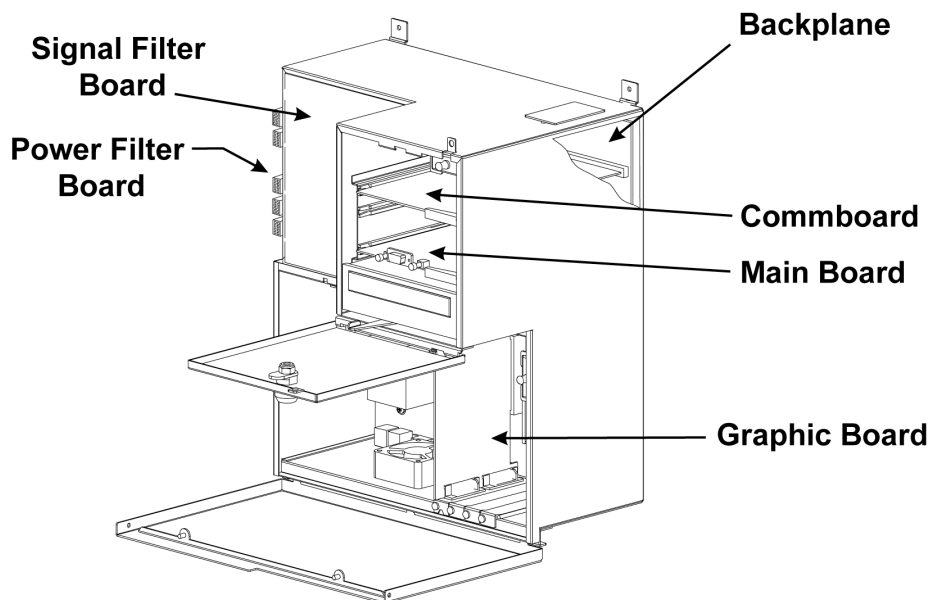
Signal Filter Board

Power Filter Board

Backplane

Commboard

Main Board

Graphic Board
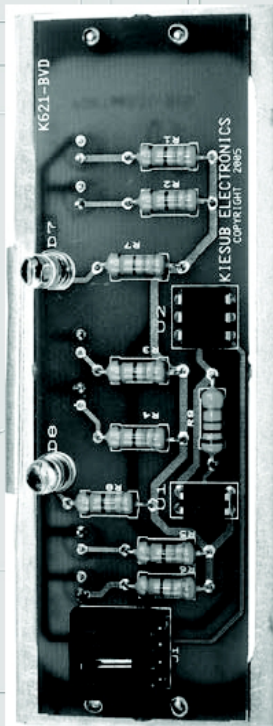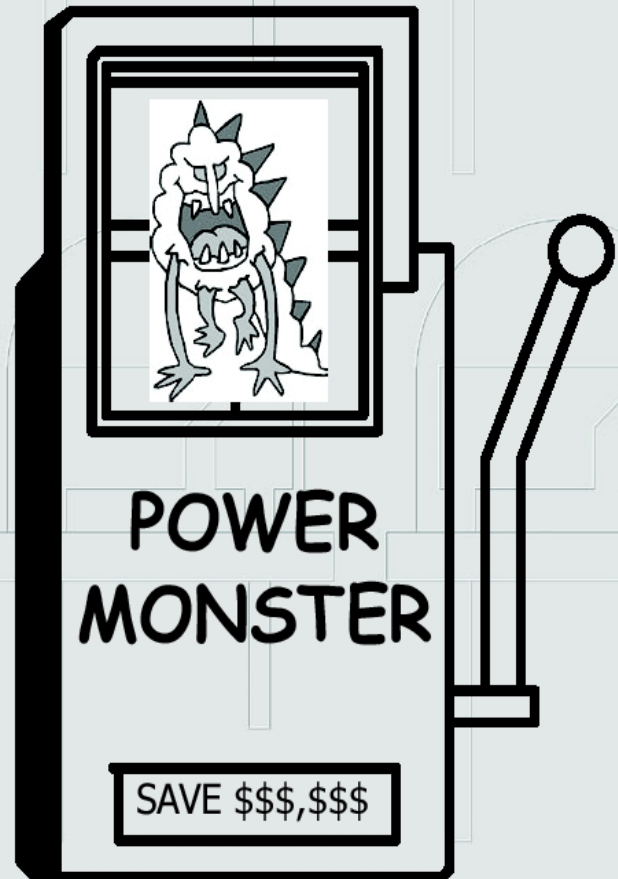
Simplified Atronic Wiring Diagram

PLAYFIELD

Down
Up

Buttonpanel
Buttonboard — P7, P11, P1, P9, P4, P5, P8, P6
Framelight Control Board — P6, P7, P3, P5, P4, P2
FL-Board -Low
FL-Board -High
FL-Topboard
FL-Board -Low
FL-Board -High
Main Display TFT 1
Upper Display TFT 2
Fan
Ballast Coil
Fluorescent Lamp
Toplights

MAINDOOR

Bill Decal
Change
Not used
Cash Out
Coin Decal
Coin In
Ticket Out
Doormotor

HOPPER DRAWER

Hopper
Hopper Board — P3, P2, P1
Coin Board — P1, P5, P6, P4
Solenoid
Coin Acceptor CC-16 or MC-16
Optodevice Dropbox
5 Optodevices
Woofer
Service Outlet
Line Filter
Power Switch
230V Out max. 1A
Power Supply
free

LOGIC BOX

Filterboard Signal — P8, P13, P5, P10, P3, P2, P6, P9, P7, P1, P4
Touch Controller
P17, P16, P15, P8, P11, P14, LVDS, LVDS
Backplane
X6, X7
Graphic Board — S12, S15, AGP
P15, P9, P7, P6
Multimedia PC Board — X11, P1, S5, X22, X5
P13, P12
X 12
DVD Drive
Fan — P 16
Main Board — P2, P3
Comm Board — P1, P3
P4
Logic Door
Filterboard Power — P5, P5, P4, P6, P5, P2, P3, P1
Fan

CABINET

Bill Door
Cashbox
Bill Acceptor
Bill Stacker
Hopper Drawer
Drop Door
Jackpot Key
Audit Key
Counterboard Lamps
Counterboard — P1, P2, P3
Main Door
Voucher Printer
Online System Components

paytable interpreter, a general game control and specifics of the unique game. The other main board EPROM (U9) is the paytable software, which contains the game mathematics and paytable on-screen data. The main board also has a microcontroller from Atmel™called a "Tiny" (U22) that is used to manage the game's copy protection demands. This Tiny is available in a stand-alone or progressive version.

The Chief Financial Officers All payroll, accounting, and finance functions are handled by the game's CFOs. Depending on the configuration of the cabinet, there are either one or two chief financial boards present.

For standard coin-in / coin-out cabinets, the coin board handles all things accounts receivable: coin-in. The coin board controls the coin comparitor, optics and diverter. These are its sole functions -- you don't need this board (and it will not be installed) if the game is configured as coinless. With many games going coinless as of late, coin board CFOs are becoming expendable, clogging up space in the unemployment line. But the hopper board CFO position is not expendable.

In addition to its accounts payable duties of controlling coin-in and the hopper, the hopper board also supplies power to the door motor and controls the door motor op-

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eration. In this case, the "door motor" is the mechanism that allows the e-motion™playfield to move up and down. Without a hopper PCB, this will not function. So, even when an e-motion™game is coinless, you still need a hopper CFO to run other functions.

Director of Accounting

Reporting directly to the CFOs is the counter board. This company "bean counter" records all information through hard meters that are located on the right side of an e-motion™cabinet. The counter board (also known as the meter board) powers and controls these meters but it also has another crucial function: the counter board has many switches running through it. For ease of connectivity inside the cabinet, wires from a total of eight doors and keys (the main door, the bill door, jackpot key, etc.) are routed through the counter board. This accounting guru is so important, you can't even get into the building without this PCB in working order. If a great majority of the doors and switches in an e-motion™cabinet are not working, check this board.

Director of IT

The members of our Board of Executives and the "cabinet" itself must exist in a true environment, communicating with external devices like accounting systems, player tracking systems,

Commboard 68k Rev 2.10 Dipswitch Overview (SAS)

Dipswitch S5

1	2	3	4	5	6	7	8	Description
Off	Off	Off						Mikohn MS-10 progressive
On	Off	Off						Accounting progressive
Off	On	Off						Atronic Progressive Link (if included in EPROM)
On	On	Off						Mikohn MS-27 mystery
Off	Off	On						Mikohn MS-27 mystery + progressive
On	Off	On						Accounting system third channel on P10 and P11
Off	On	On						Not used, defaults to Mikohn MS 10
On	On	On						Not used, defaults to Mikohn MS 10
			On					APL machine acts as master
			Off					APL machine acts as slave
				On				Activate implemented accounting system
				Off				Disable implemented accounting system
						On		Handpay and ticket overwritten if not read
							On	Only ticket info overwritten if not read

Pins header spans columns 1–8

Dipswitch S8

1	2	3	4	5	6	7	8	Description
	Off							Prog JP, Chan 1
	On							Prog JP, Chan 2
		Off						EFT, Chan 1
		On						EFT, Chan 2
			Off					Bonus, Chan 1
			On					Bonus, Chan 2
				Off				Control, Chan 1
				On				Control, Chan 2
					Off			Coupon, Chan 1
					On			Coupon, Chan 2
						Off		Commboard sends total drop meter to host
						On		Commboard sends coin drop meter to host
							On	Message if accounting system is not connected
							Off	No message if accounting system is not connected

Pins header spans columns 1–8

Rotary Switches

Switch	Function
S1	Game's progressive system address
S2	Game's progressive system address
S3	Game's accounting system address channel 2 (auto enable 2nd channel if set)
S4	Game's accounting system address channel 2 (auto enable 2nd channel if set)
S6	Game's accounting system address channel 1
S7	Game's accounting system address channel 1

NOTE: Functions can vary when different software is used.

progressives, TITO systems, and more. Someone has to coordinate all of this, making sure all wires and switches are set up correctly.

The communication board, or commboard, handles all the game's communication to external devices. As the king of external e-motion™information technology, the commboard accomplishes its tasks with the help of two underlings, U34 and U35. These assistants are EPROMs, which run the commboard 68k software. In

addition, when Atronic games are connected as an Atronic Progressive Link, the commboard functions as a jackpot controller.

Like any good manager, the commboard is flexible to accommodate the presence of many possible external systems. The commboard can be customized by moving rotary switches to certain positions and by flipping dipswitches. Refer to the figure for detailed information about switch functions.

Chief Security Officers

Someone has to protect the important board big-wigs and that responsibility lies with two Chief Security Officers. These two valiant pcbs (the signal and power filter boards) are the most physically dominant and act as shields, protecting all e-motion™wires and electronic components from evil invad-ing surges. The signal filter board is a filtering device that keeps any harmful RF frequencies generated by the machine from reaching the logic box and its components.

The signal filter board stands guard twenty-four hours a day, maintaining an intense vigil. Every wire and device (like speakers, the bill validator and other circuit boards) is routed through this security board. There are five exceptions -- five cables and wires that do NOT go through the signal filter board. These exceptions include the player tracking harness that runs from the commboard to the specific player tracking unit and two output wires that run from the graphics card to the upper and lower TFT displays. The other two wires that are not routed through the signal filter board are two serial cables that are connected to the multimedia board: one cable runs to the touch screen controller, while the other cable goes to the frame light control board.

While the signal filter board provides one aspect of protection for the logic box, the power filter board mans another line of defense. One hundred percent of the power coming into the game goes through the power filter board. The board protects everything in the cabinet from harmful EMI (electromagnetic interference) and inadvertent power surges. In the unlikely event of a security breach in the form of a power surge generated from the power supply, the board will become a martyr to protect the other components. It takes its job so seriously that it will stay at its post and absorb any high voltage power problems coming from the power supply, possibly sacrificing its own life. What an employee.

Directors of Marketing

Even if the Board of Executives functions perfectly inside the cabinet, nobody would want to play the game if it weren't for the Director of Marketing boards. The graphics board, multimedia board, and frame light control board bring excitement to the game-- making it stand out on a casino floor. They control the snazzy graphics shown on the displays and they animate the surrounding flashing lights.

Located in the logic box, the multimedia board controls all sound and video animations. The board offers various interfaces, such as USB, serial, Ethernet, IDE, AGP (accelerated graphics port) and PCI. This position is usually held by the CEO's nephew.

The graphics card controls the e-motion™TFT monitors as instructed by the multimedia board. The processor on the multimedia board controls the graphics chip on the graphics board through an AGP bus. The board uses a resolution of 800 by 600 and 65,000 colors. The TFT brightness is also controlled by the graphics card. In addition, the TFT power comes from the graphics card. To reduce the number of wires routed to the playfield, the power line to the TFTs is included in the same cable as the video.

The frame light control board supports the multimedia and graphics boards. The lights surrounding the TFTs on the playfield are called frame lights, which are controlled by this board. It acts as publicist, managing the color and animation effects of all the colored LEDs. It sets up shop in the adjustable playfield, behind the lower TFT.

Director of Customer Service

When the Marketing Department does its job and the player is drawn to the game, the director of customer service (button board) must serve as a liaison between the external player and the Board of Executives within. The button board makes its home in the button panel in the playfield. It possesses inputs from the button switches but also has some important outputs. It controls all the LEDs under each button and acts as a distribution station for DC power. Both the frame light control board and the fluorescent light on top of the playfield get their power through the button board. When a frame light or lamp around an e-motion™playfield is lacking power, the button board may be taking a nap at its desk.

Director of Human Relations

The responsibility of making sure all members of the Cir-

cuit Board of Executives get along together and function as one cohesive unit lies with the Director of HR, the backplane board. The boards in the logic box mount to the backplane board, which distributes the DC power to all boards in the e-motion™cabinet. The backplane also connects the signal lines between the boards. It keeps the internal lines of communication up and running, regulating inter-board relationships and organizing events like dress-down Fridays.

This hard-working and efficient crew of pcbs composes the Atronic Printed Circuit Board of Executives. Each individual personality provides a different area of expertise but all function in workplace harmony to ensure that the e-motion™gaming machine performs at optimum capacity. All's well during just another day at the office, at least until the trap board security officer is busted by the HR backplane for putting his leads on the accounting manager's integrated circuits...

- Michael Brennan

(e-motion is a trademark of Atronic. And thanks as usual to Atronic Technical Trainer Corey McGovern for his contributions.)

Understanding Video Reels Part 6 of 6

By John Wilson

You have just returned from a nice lunch on a warm, sunny, Friday afternoon. You're hard at work on a new billion-dollar wide-area progressive link for a penny machine. Looking up from your desk you see your good friend Larry, a thick file folder in hand. "We have a rush assignment!" he states. You sigh deeply, knowing that tomorrow's golf game has just been cancelled.

"What's up, Larry?" you ask.

"The big guy wants us to fix up a new game. It's scheduled to be installed in the Slot Tech casino Sunday for a field test beginning first thing Monday morning. There's a problem with the math, though, and they can't get it fixed."

"Ok, fill me in on the details." you reply.

Larry sits down and passes you the folder. "It's a five-reel video slot game that has been custom designed for Slot Tech's casino in El Cajon. It's a brand new design with nine symbols and a scatter pay. The cycle is just over 6 million games. There are 470 entries in the paytable and they've been able to get a 27% hit frequency."

"That's the hit frequency per game?" you ask.

"No, "replies Larry, "that's per line. The game hit frequency is over 80%."

"Hmm, "you ponder, "I'm guessing that the problem is the payout percent. What is it?"

"Just over 200%", Larry states.

"Bonus game?" you ask.

"Not yet. It's just a simple game to test the theme and overall play. There's going to be at least one bonus game added to the base game, but not until the base game is complete. I suspect our bonus game will be like the Max Millions game we did a while back. We'll have to develop a demo game with 3D graphics to illustrate the math."

"Is it going to be like Max Millions?"

"No, I have some ideas on the game. It will be a lot fancier than Max was."

You look at the PAR sheet in the folder and read over some of the design notes about the game. The game looks good, but you're not sure how to proceed with the fix. "What are you thoughts on this, Larry? How do we get the game down to, say, 95%?"

"There are a few methods that will bring the game into a reasonable range. Firstly, we could reduce some of the paying amounts. This would leave the hit frequency the same as we don't adjust how often the payouts are awarded, just the amount that we pay out each time. By decreasing the amount we pay out each time, the payout percentage will decrease as well. The top jackpot is 50,000 credits. Let's assume the player is playing nine lines at a time. That gives us 9 credits for the cycle of 6,339,168 games. During

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one cycle we take in 57,052,512 credits. The payout is actually 202.29%, which means we're paying out 115,411,527 credits. To make the game at 95%, we must cut out 61,266,641 credits. The jackpot occurs only once and is 50,000 credits. If we knock this down to 25,000 credits our payout percent drops to 202.25%. There's still a long way to go."

"I see." you reply. "In other words, the jackpot isn't the problem. Is there a single payout that accounts for a large percentage of the paying amount? We have 470 paytable entries. That would suggest that no single payout is going to account for a large percentage of the total game payout? "

"Correct. In fact, the largest payout is only 1.5% of the total machine payout. This means that we have to decrease a number of awards in order to drop the payout. If we look at mixed candles, for example, there are around 340 paytable entries for combinations of three, four and five mixed candles."

Larry takes out his notebook computer and sets it on your desk. Loading VC Slots, he opens up the Slot Tech video slot game and soon has the game configuration on-screen. This tells us that there are 1,729,884 winning games per line. The mixed candles accounts for 1,198,240 games, or 69% of all of the winning games."

"That certainly points us in the right direction." you surmise. "Seven out of ten winning games will be mixed candles - either three, four or five. If we change that payout it will make a significant difference to the game play. How much do we pay for mixed candles?"

Larry checks the screen and replies, "Three mixed candles pays five credits. Four pays ten credits and five pays 25. I think you're right. Let's pay three credits for three candles, five for four mixed candles and ten for five mixed candles." Larry makes the changes to the paytable and has the software recalculate the results and regenerate the paytable.

"Here it is. If I just group the mixed candle payouts together and total them we get ¼ 139.90% payout. That's dropped quite a bit. Maybe we should look at"tickets & tokens." If we drop them down a bit, let's see, reduce these and, now over here, yes, perhaps, let's recalculate. Hmm, that only drops us down to 133%."

"Right, "you say, thinking aloud, "we pay for two jackpot symbols but also two red 7s. What portion of the total payout is assigned to the two red 7s? If we remove this payment entirely, perhaps it will drop us below 100%?"

Larry studies the PAR sheet for a moment, locating the two red 7s paytable entry. "There are just over 17,000

hits for this. Remember, we pay only left to right. The total contribution is 1.02%. The hit frequency for this payout is just under 1%. That's not going to help. Maybe if we lower some of the other payouts. Perhaps the natural candle payouts?" Larry makes the changes and determines that the payout percentage drops down to 130%.

"Could it be the scatter pay? That has to account for a lot of wins. Let's see, scatter pay symbols award two credits for any three, five credits for any four and ten credits for five symbols. What if we try to reduce the frequency of scatter pays? We're still over 20% hit frequency and decreasing the paying amounts hasn't fixed everything yet. Try reducing the scatter pay symbols." you direct.

Larry studies the reel strips and states "Ok, here they are, scatter symbols. We have 4, 3, 2, 4, 2 on the reels, for a total of 192 hits. If we decrease it to 3,3,2,3,2 then we drop to 108 hits. Let's see how that works."

You study the symbol table for a moment. If we decrease the number of scatter pays, then we decrease the overall size of the cycle, right?" you ask.

"That's correct. We're making a smaller game because we have less symbols." answers Larry.

"Then that means that the

other payouts should increase slightly. If mixed candles, for example, account for 100,000 of the cycle and we decrease the overall cycle, we'll still have 100,000 mixed candles but fewer games overall. That means that the hit frequency of mixed candles will increase. How does that affect the overall game?"

Larry makes the changes and recalculates the statistics. "The game cycle has dropped to 5.8 million games; the hit frequency is now 25.64%, which isn't much lower. And the payout percentage is, are you ready? It went from 130% and is now... let's see... it's 139.95%. Hmm, it increased almost 10%. I guess we're going to have to settle in for a busy afternoon. Well, let's tell the boss that we've gotten much closer and are going to have to 'fine tune' the configuration from here. What do you take in your coffee?"

The dynamic duo continues to work throughout the afternoon, studying the symbol table, reel strips, paytable and making changes to the entire game. Part of this is trial-and-error; part of this requires analysis of the play statistics to make educated predictions of how the game will change. After several attempts to get the game playing correctly, the team gets close. Each time a change is made, if affects other areas of the game. Sometimes a decrease in payout in one area increases another area.

It's a balancing act. It's getting late in the evening and we join our team again . . .

"Well that one certainly didn't work." you muse. "Let's go back to the one where the payout was in the low hundred percent values."

"Didn't that one have a very low hit frequency?"

"Yes, but I have an idea. Let's try to reduce the cycle. Perhaps that will give us better control of the symbols vs. pay."

"I'm not exactly sure that I'm following you."

"Now that we've changed the payout values as much as we can, we have no option but to change the number of hits for each symbol. We'll scale back the number of symbols to a minimum and then start adding more to the game, monitoring the overall affect after each change."

"And if that doesn't work?"

"Then we use different strategies. We could remove one symbol altogether and see how that works. We could add in another symbol, too. We

still have a lot of avenues to explore."

After a while, our team is getting close.

"Alright, let's calculate our probabilities again." you add.

"That looks better." exclaims Larry. "What did we end up with? The cycle is lower - 4.7 million games. The line hit frequency is 18% and the payout is 98%. What's the overall game hit frequency?" Larry starts up the simulator and has it run through the game, checking the payouts. "It's going to be 71%. That's only 10% less than the original configuration. And the line hit frequency is less than 10% lower. "

"It looks like we have a winner on our hands!" you boast.

"I don't mean to burst your bubble, but what about the bonus game? We don't have enough room in the payout percentage to include a bonus game." worries Larry.

"We just have to tweak the results a bit. We have to determine how much we want the bonus game to pay and then remove that from the base game. Chances are it will only be a few percent. We can adjust the game slightly to remove that much without any problem. Since the biggest aggregate payout is the mixed candles, we could just concentrate on those symbols."

"Alright. Let's generate the PAR sheet and I'll run it upstairs. The big guy is going to be pretty happy with this."

"Just wait until he sees the bonus game!"

We leave our dynamic duo after finishing the video game. They're already making plans for the bonus game. Will the big guy be happy with the current game? Will you be able to make your golf game after all? Will Larry notice a problem on the PAR sheet? Stay tuned for a future episode when we battle The Curse of the Video Bonus.

- John Wilson
jwilson@slot-techs.com

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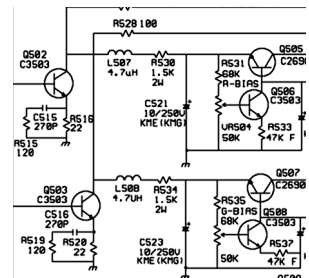
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Power supply failure is a common complaint in many different types of systems. Power supply failures are discussed during the class, along with shortcuts for troubleshooting and repairing them.
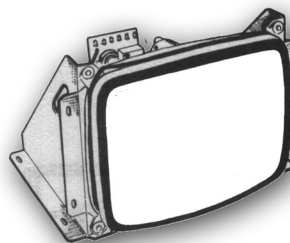
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Quick and Simple Repairs # 10

By Pat Porath

I GT Fort Knox Hard Meter Problem

This was an interesting ordeal. Usually, when an IGT video game has a problem that shows "meter disconnected" or a general meter problem, it is an I/O card that is loose. The game needs to be turned off and the card needs to be put back in place, problem solved.

Not this time. On this game, I checked darn near everything. I reseated all of the I/O cards, reseated the main processor board, checked the connections on the hard meter assembly, and checked the connections on the back plane board and such. Nothing seemed to help the problem.

It was during the weekend at the time and I didn't really want to call the IGT regional tech so unfortunately, the game had to be shut down. At our casino, the "Fort Knox" games are extremely popular and we DO NOT want to shut them off for any reason at all but in this case, there wasn't much choice. Like I said, everything that I could think of, I had checked. The con-

nection of the hard meter assembly was reseated, the chips on the main board were snug, all looked good but the "meter disconnected" error would not clear.

With the game down overnight, the next day it had to be checked again. I remember a little phrase that my buddy Chip told me:"The machine was made my man, it can be conquered by man." With that in mind, the game was turned on. What was this

clicking noise? It wasn't there before, what in the world is it? I looked around and noticed that the coin-in hard meter was going crazy. Ok, there was a meter problem and now the meter is going nuts, maybe the problem is solved? I let the meter increment for a bit and closed the main door and bingo. It was playable, THE TILT WAS GONE.

The last bet was also noted. Whoever was playing the

standard game hard meter

game before it went on tilt was betting max. On that particular game, max bet is 500. So a customer spins the game only three times and then the coin-in hard meter has to increment 1500. I'm not sure how long the customer was playing the game but it must have been a while. I never heard of that specific machine running into a meter problem after that. IN THEORY, a customer was playing the heck out of it, betting max for who knows how long, the hard meter couldn't take it anymore and over heated. The next day it "cooled off" and was operational. I talked to my manager and he agreed. Good theory. In conclusion, you may want to have a set of hard meters on hand just in case.

Williams Slant Top Printer Problem

This is an older Williams slant top game that uses the Ithaca 750 ticket printer. The problem was a "printer communication error" that would not clear for nothin'. A fellow slot tech had replaced the printer head, the complete printer assembly, preformed a ram clear, tried the complete unit in another game and such. Nothing seemed to work. I can't exactly repeat what he said but with a few choice words added, he asked, "Pat will you look at that thing?"

There wasn't much going on at the time; so sure, "I'll check it out."

The usual things were done such as checking connections, reseating the I/O board, reseating the main processor board, making sure it had power, things like that. Sure as the sunrise, "printer communication error" came back. Since parts were swapped around (you got to love swaptronics) it may be a software problem. I checked the options of the game. It knew that there was a printer installed, communication was set at "SAS 5" the ticket expire date was correct and all of the game options seemed correct.

On our floor there are Ithaca 750 printers used in the Williams games AND certain Aristocrat games. Could it be a software problem with the printer head itself? I took the complete printer unit out of the problem game and brought it to a similar game and installed it. Sure enough

it came up with the same error. I used the known good printer head in the other unit, and it worked fine. Three test tickets printed A-ok. Now the problem points toward the printer head itself. With a handy-dandy flashlight, I peered at the PLCC chips. Yes, looks like a software problem. The known good printer head had a Revision 19, while the other had a four-digit number on it. At the shop another Revision 19 chip was found and installed. Will this do the trick? The printer head looked like it was new, so hopefully it didn't go bad during the swapping around of parts. Back at the game with a known good printer assembly, a visually good-looking printer head and a Revision 19 chip installed in it, maybe this game will work.

Very carefully installing the complete unit, making sure
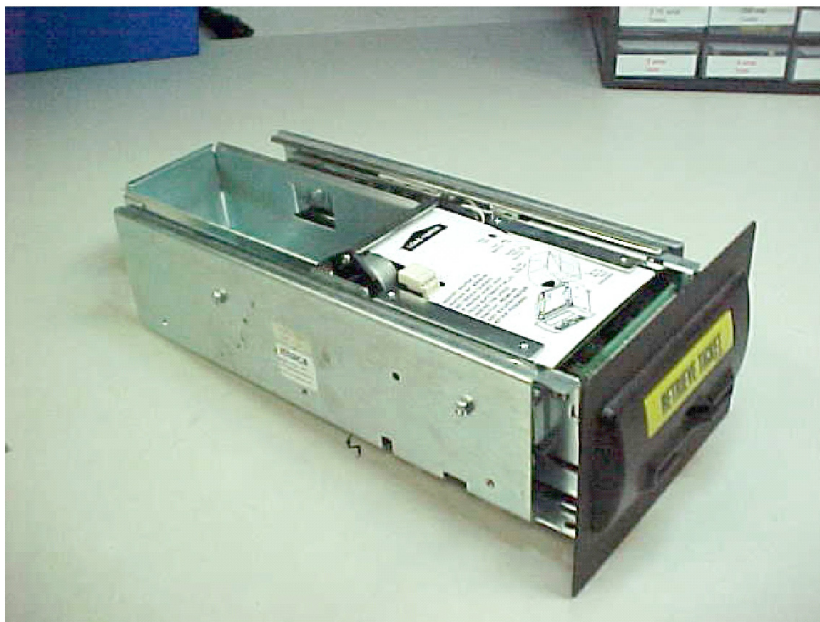
This is the Ithaca 750 printer that is used in the older Williams games, and also used in some of the Aristocrat games. Once the head is removed, it is very easy to see which version of chip is installed in it.

the connections were correct, the game was turned back on. YES...the problem was solved. Three test tickets were printed. The game was back "online." I brought one of the test tickets to my fellow tech and he said he could almost kiss me. I told him that it was quite all right; NO thanks. :-) In a nutshell, you may want to check the software that is in the printer head if a few different people have been working on a game.


Here is a really cool flashlight kit made by Coast. As techs, we know how important a good flashlight is. This unite seems to be made of decent quality and comes with a carrying case and attachments. It can be found at your local Wal-Mart in the fishing department, not the flashlight department. It comes complete with the batteries, the three LED very bright light, the single LED red light, and two wands that screw onto the ends. The kit includes the carry case with a belt loop. On the three LED light the attachment that connects to it shines light in a broad area. When put in the top part of a slot machine, a lot of light will be put out over a broad area, not just one small area. With the small light, it has a red LED that flashes slow, flashes fast, and can be on steady. I'm not really sure what it can be useful for but I did use it once while working in a hallway and had it blinking. If anyone asked I was going to say "Caution...Tech at Work." The light from the larger one is VERY bright; you can't even look directly at it without hurting your eyes. I enjoy the neat case that carries it all too. If you get the chance, go to Wal-Mart, and check one of these dandy flashlights out. They are around $20 to buy and to me, they are well worth it. Of course with almost everything there is a downfall: the batteries. They are half the length of an AA type, and may be expensive. The larger light takes three and the small one takes three button type batteries. I'm quite sure Radio Shack has them in stock. Like I said, it is a very cool light, if you get a chance, check it out.

CDS. Scrambled Display?

Do you ever run into a CDS. display that is scrambled or looks like the language may be in Greek? Once in a while I run across one and can get it back working in a few minutes. Though there are other times that the E square chip, or the whole Sentinal board needs to be replaced.

Sometimes this little trick works: Power down the Sentinal board and remove the RAM chip. Scratch it for a few seconds and power up the board WITHOUT the RAM chip in it. It sounds pretty weird, but sometimes it works. With power applied to the board install the chip, and within five seconds the display should be back to normal. I was working with a fellow slot tech Dean and he had a scrambled display. I went to the game, did the "scratch trick" and it was fine. He had asked me later on in the employee cafeteria how I got it working again, I told him that it was magic. "Pat, tell me what you did or do I have to read it in Slot Tech Magazine?" It was funny.

EPROM and RAM sockets

Communication chip
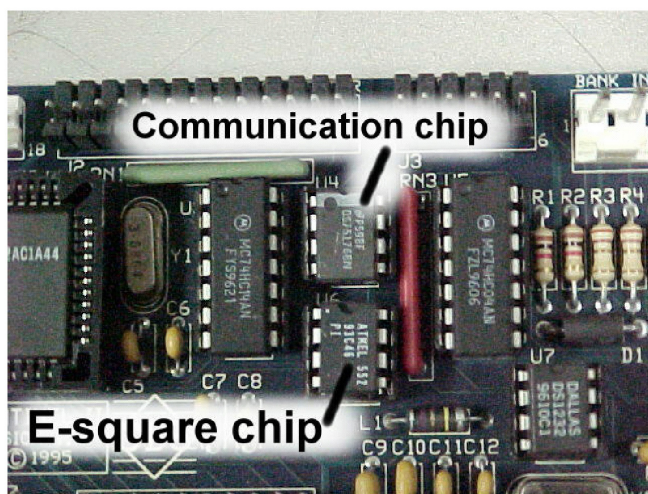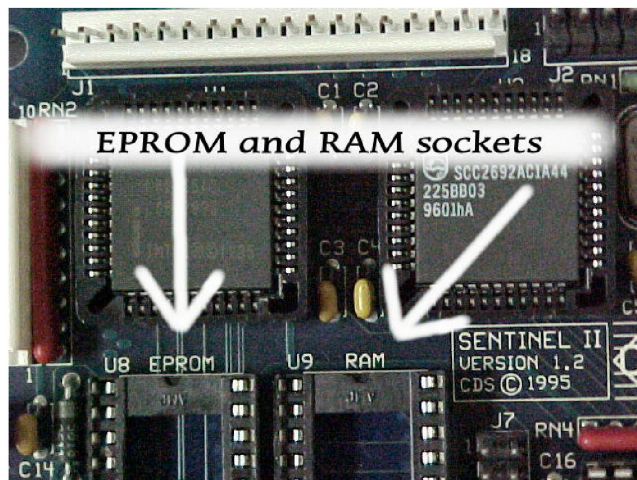
E-square chip

As shown in the picture, the RAM socket on the Sentinal board is located at socket U9. The white display connector is just above it. The EPROM is located at U8.

In this picture of a Sentinal, the communication chip and the E square chip are shown.

The communication chip is the eight-leg chip with the wide stripe on it, at socket U4. Just below that is the E square chip, located at U6. If there are communication problems in a bank of machines that may be intermittent or if the majority of the bank of machines is off line, check your COM errors with your tech card and it may be that only the COM chips need to be replaced. The E square is rarely replaced.

If there isn't a display, or if the display is locked up, sometimes the replacement will do it. Most of the time, only the RAM chip and the COM chip are dealt with. You will also notice on the upper right hand corner, the white two-pin connecter. It is marked "bank in." Sometimes, the wires that are in that connection become a little bit loose. The "bank out" also. When there are communication problems, check that the wires at these two locations are nice and snug. A small flat tip screwdriver works very well. A new COM chip and snug connections will usually get the bank of machines communicating well again. With "promo cash" (customers download credits to games) and with ticket printers, communication between the slot machine and the tracking system has to be near perfect. Without it, some games will lock up for a hand pay on every cash out, even 50 cents. Not good.

Bally 6000 Upright Reel Game

A slot attendant called me over to a standard Bally reel game and stated that whatever he did, the error code 20 would not go away. Alright, on a Bally the error code 20s have to do with coin-in, the 30 codes are the hopper or printer, the 40 codes are usually reel tilts, the 60 and 80 codes are RAM errors. With that in mind, a code 20 had to be a coin-in problem. On that model of Bally coin-in optics there is a small yellow light which indicates if the optic is blocked or open. I couldn't remember which was which at the time, so I carefully put in my small screwdriver and wiggled it a bit. The yellow light went off and on showing that the optic was working. Then the belly door was opened

to see the prism to make sure it looked good, had no cracks and it was in place. I took my small screwdriver again and fed it into the coin-in assembly. A small piece of paper came out. It was tiny but just the size to screw it up. The main door was opened and closed a couple of times and THE TILT WAS CLEARED. I showed the slot attendant the small piece of paper and he could hardly believe that such a small thing could screw up a machine. I don't recall the specs, but there are a certain number of milliseconds that a coin has to be in the optic and pass though. After the time has passed and everything isn't correct, the game will tilt. This may have started with the old trick of trying to "string" coins in slot machines. The optic works a lot better than the old metal wire and switch that used to be in slot machines. In conclusion, a very small piece of paper that is in the coin-in optic of any slot machine WILL make it tilt. If a game has quite a few coin-in tilts it may only be dirty optics. It may be lint or coin dust. You may say, coin dust? After a machine has thousands and thousands of coins run through it, coin dust does appear. So if a game does have some coin-in tilts try removing and cleaning the optics. More than likely it will solve the problem.

- **Pat Porath**
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Slot Tech Training at Thunder Valley Casino

If you're ever in the Sacramento, California area, you'll want to make it a point to visit Thunder Valley Casino. It's really a nice property. Slot Tech Magazine was there for two weeks of tech training. Fun!

(l) Thunder Valley Casino Slot Director Bryan deLugo, Ted Kernan, Herb King, Dirk Plunkett, Joe Kelly, Robert Ramey, Ed Samonek, Slot Technical Director Don Jennings and Slot Tech Magazine publisher Randy Fromm.

(l) Randy Fromm, Jeff Ksander, George Periera, Micheal Krout, Henry Tran and Dave Smith.

Math Mayhem

Aristocrat Launches Litigation against IGT

By John Wilson

On December 14th, 2005, Aristocrat Technologies, Inc. filed a patent infringement lawsuit against IGT. Aristocrat alleges that IGT infringed on their Reel Power® patent by creating IGT's MultiWayTM slot machines. This litigation is timely for Slot Tech Magazine readers as we've been talking about this very math! In this article we'll discuss the theoretical math behind these games and how it affects the players. We're not going to discuss specifics about how each manufacturer creates the payout patterns mentioned in the litigation but will instead stick to a theoretical study of the video math. There won't be any discussion of the lawsuit or any opinion on whether the MultiWay game infringes upon the patent. That's best left to a team of lawyers**.**

IGT's MultiWay 243 ways to Win

The MultiWay Wagering is found on IGT's Game King® enhanced video slot series. According to IGT's marketing brochure, this allows "players to buy reel positions rather than wagering on standard line patterns - with

up to 243 ways to win on a "3 x 5" game!" If you remember Video Reels part 3 (and how could you forget?), I mentioned "By expanding to five reels, we could create 243 paylines. Interestingly enough, there are a few new video machines with 243 paylines.

Aristocrat's Reel Power®

Aristocrat states that "Reel Power® video slot technology [is] a unique style of game in which players purchase reels rather than lines, enabling 243 different winning combinations." The similarity here is with 243 winning combinations, ways to wins, paylines, etc. I'm not saying

that both of these games are the same, but there is a similar mathematical premise underneath. Don't confuse this with saying that the games are created similarly, or that they share the same math! The end result is that they both have 243 ways to win. How they implement this and how the underlying math is done isn't being discussed here.

243 is a Magic number but so is 3,125!

There's magic in math. And 243 is a magical number. At least when it concerns certain slot machines and combinations. And this suit brings to light an interesting

Figure 1: Your standard five-reel, three-symbol game allows for 243 paylines. This is based upon the assumption that you are using one (and only one) symbol on every reel.

concept. To the slot player, it appears to be smoke & mirrors.

Let's examine a simple slot machine. Remember the Blazin' 7s created in Slot Tech Magazine a while back? It was a three-reel slot machine with various symbols on it. Let's walk through a sample game and see what goes on inside.

Randy Fromm's Slot Tech magazine.

You insert a ticket or some tokens into this game and have some credits on the credit meter. You then decide the play a game and press BET MAX. In the case of our game, three credits are used for your wager. This is pretty straight forward so far, and I assume everyone is following me.

Let's study a few different ways that the machine can proceed.

Method 1: Virtual Reels

The processor, having started a game, fetches a number from the game's random number generator three times - one number for each reel. In our case the numbers 34, 23 and 16 were selected. After looking up the virtual stop values in a table, the machine maps these values to positions 9, 11 and 12 on the physical reel strips. The reels spin and their positions are monitored. After the three-second timer elapses it's time to settle the reels on the proper symbols. The first reel will pass the "Start of Reel" sensor and continue to spin until the ninth symbol is at the payline. This reel is stopped and the 2nd and 3rd reels are stopped in the proper position as well. Virtual stops 43, 23 and 16 are on the payline, which is the same as physical reel positions 9, 11 and 12. These physical stops are the symbols Red 7, Red 7, Double Red 7. After a query of the paytable a match is found: Any 7, Any 7, Any 7. For three credits wagered the player receives 225 credits.

This is added to the credit meter and the slot machine waits for the player to press a button: "Bet One", "Bet Max", "Cash Out", "Service" etc.

Method 2: Class II

The processor, having started a game, signals the main server that a game request has occurred. As this is a Class II game, there must be at least two players. After a wait of several hundred milliseconds (yawn!), two additional slot machines join in the fun. The server initiates a new bingo game and draws 75 balls. Studying the bingo cards for each game, a matching winning pattern is found after 18 balls were drawn. The other two slot games didn't have any matching pattern after 18 balls, so they lose. The pattern matched shows a payout of 225 credits with three credits wagered.

Now the processor starts to spin the reels and looks up a pattern of symbols that will result in a 225 credit payout. It finds that Mixed 7s would satisfy this requirement. Randomly selecting symbols, it may decide upon Red 7, Red 7, Double Red 7. The machine must not pick three identical symbols, as that would not be "Mixed" 7s. After a three-second spin, the machine stops the reels making sure the proper symbols are displayed. The player receives 225 credits for this win.

Method 3: Paytable-Drive

The processor, having started a game, queries the random number generator for a value that will be the probability factor. Once the number is obtained, it is checked against the paytable for a match. In this case, the random number matches a payout of 225 credits for three credits wagered. Each entry in the paytable has an appropriate probability in this version of the game. The Mixed 7s payout has a probability of 0.002943, which matches the value just selected. The outcome is based upon the payout amount, not the symbols that pay this amount. The end result is the same but the factor used to determine the outcome of the game is quite different. WMS Gaming used this method in some of its earlier stepper models. Incidentally, this was done so that the technology covered under the Telnaes patent wasn't used. IGT sued WMS Gaming, claiming an infringement of the patent. In 1999, after a six-year litigation, IGT was awarded $28.67 million in damages. The court also ruled that WMS had violated the patent, but had not done so "literally". The Telnaes patent expired in 2002.

Moving back to the slot game, the reels start to spin and the player watches them spin for three seconds. Next matching symbols are chosen to award the pre-determined payout and each reel is stopped, showing the se-
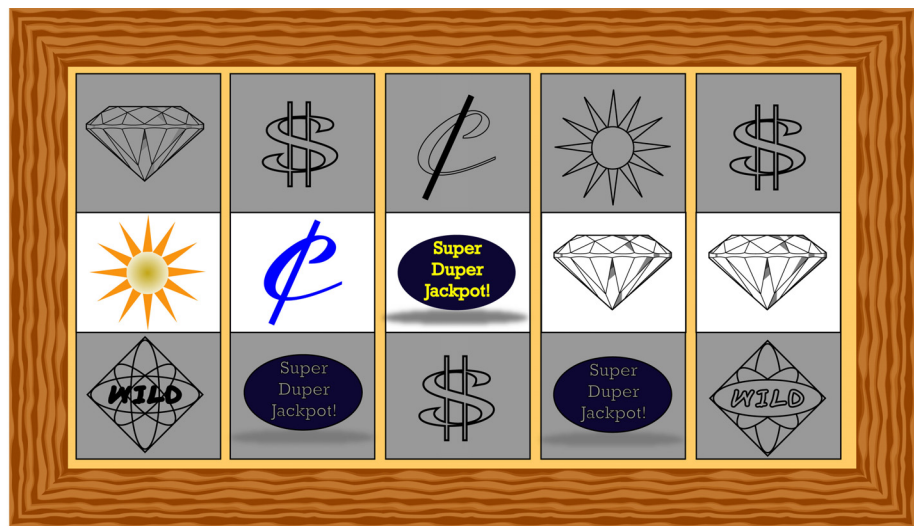

Figure 2: We have purchased only the first payline.
For a "buy a reel" game, this would be the minimum purchase, one symbol on each reel.
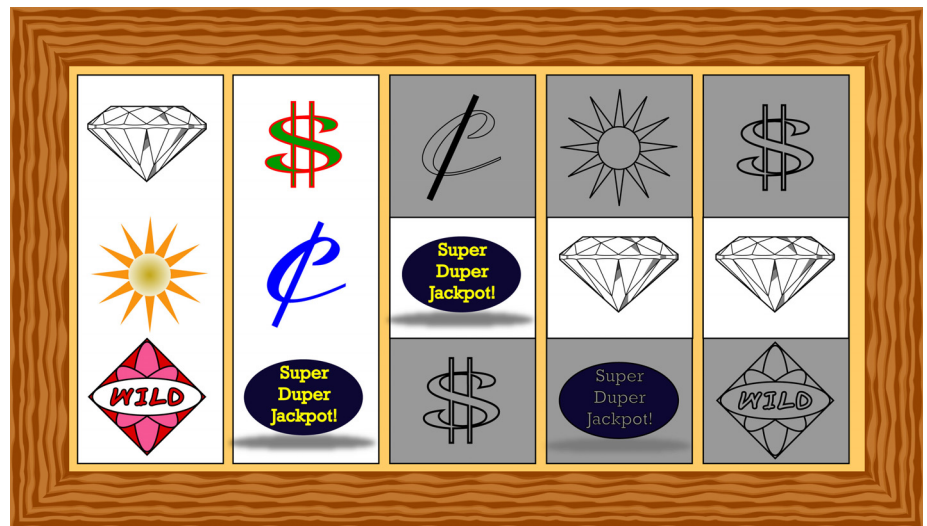

Figure 3: Here we have purchased 9 paylines.
Or, we have purchased the base (1 symbol on each reel), with additional credits going towards the complete symbols on reels #1 and #2.
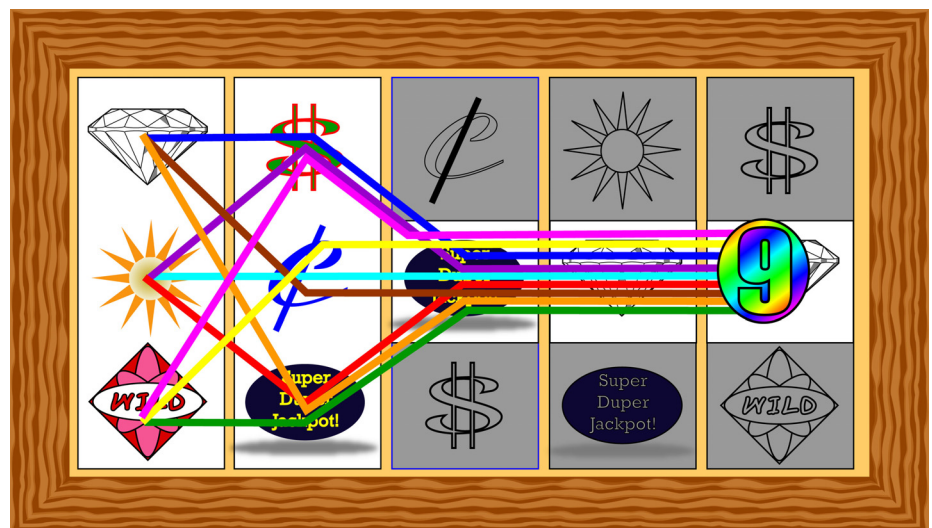

Figure 4: Here we show 9 paylines.

lected symbols. Credits are added to the player's meter (in this case, 225 credits) and the machine patiently waits for the player to do something.

The Players' View

To the player, each of these games appears to play the same. The reels spin and stop on Red 7, Red7, Double Red 7. The Class II player can watch the bingo game take place if they are so inclined. However, the end effect is that the player wins 225 credits, the same symbols appear on the payline, and it really looks the same to the player.

"Underneath the hood", things are totally different. The games do not play the same. They may look the same, but they really aren't. Is this the case of IGT and Aristocrat? They may be coming up with the same result, but using very different algorithms and routines to do this. Or, they may not.

With a 243 line game, this can be accomplished in a number of ways. Firstly, there's simple paylines. They don't look simple on the video screen, but they really are just a payline. Each reel has one (and only one) symbol active for each payline. The number 243 comes from the following:

3 symbols visible on reel 1 3 symbols visible on reel 2 3 symbols visible on reel 3 3 symbols visible on reel 4 3
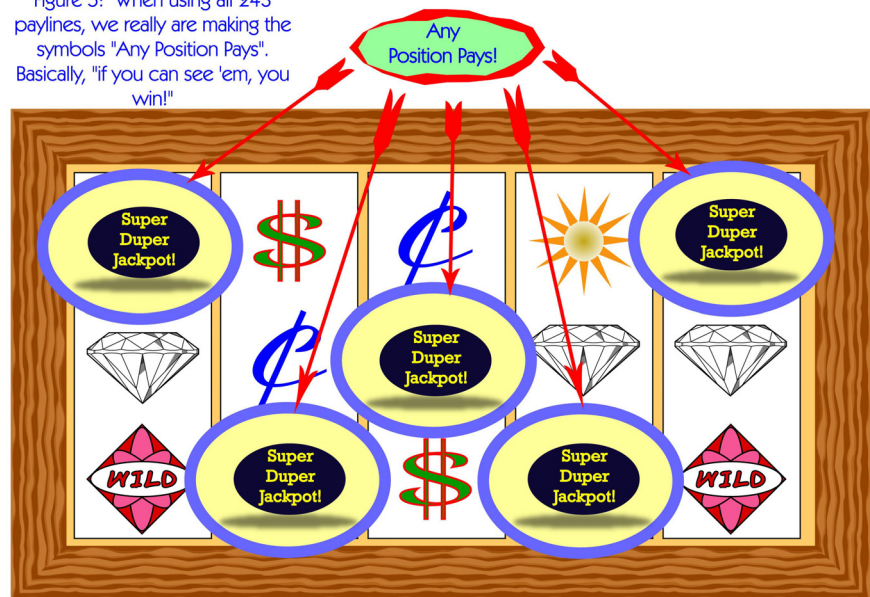
symbols visible on reel 5

Each of the number of symbols are multiplied together yielding the total number of combinations.

3 x 3 x 3 x 3 x 3 = 243 (Can also be shown as 3 raised to the power of 5)

Figure 1 shows this configuration. There aren't any reels where a symbol isn't used and there aren't any reels where more than one symbol is used. 243 becomes a

magical number. What about our second 'magical' number? Yes, 3,125 is just as magical. In this case a video game with five symbols visible on each of the five reels is created. Five raised to the power of five (5x5x5x5x5) gives us the answer ..... drum roll ..... of ..... further suspense ..... 3,125. Isn't that interesting? Using four visible symbols on each reel would result in(4x4x4x4x4) 1,204 combinations. Of course ten symbols on each reel would be ...

just plain silly!

Is a Combination a Payline?

The terms 'combination' and 'payline' have been used in our examples. Are they the same? Legally, they may be or they may not be. Mathematically, however, I'd say they are. At least they are when following the rule of "one symbol on each reel". The first 'combination' of symbols would be the center symbol on each reel in an horizontal line. This is also the first payline. As various combinations are selected, they really are just paylines. Working with the first nine combinations is the same as working with the first nine paylines. For our purposes, the words can be used interchangeably. Furthermore, the actual sequence of paylines doesn't really matter either. Payline four could be created in a "V"-shape and payline five in an inverted "V" shape. These paylines could also be created using a different combination of symbols. Perhaps payline 129 becomes the "V" pattern and payline 130 becomes the inverted "V" pattern? It's really not that important to our math.

Graphically, purchased symbols can be shown in a manner like IGT does with their MultiWay games (see figure 1). The same technique could be applied to current video games. A 20-line game with only a few lines purchased could have only those sym-bols that apply to the purchased lines highlighted. With the 20 payline game purchasing only the first payline, the video screen looks like the one shown in Figure 2.

On the MultiWay, this appears to be what is happening. Buying only nine of the 243 paylines results in the combination shown in Figure 3. By adding the actual paylines, a screen similar to the one shown in Figure 4 results.

There's no reason why the math model cannot be designed in any way desired. In the examples shown before, all reels are bought starting from the left-hand reel. The game could be designed to allow the player to any reel, perhaps just the center one.

Stepping back from the game design for a moment, and looking at the video screen, an interesting pattern forms. This 243-payline combination is really just an "any position pays" paytable. Working with every possible combination of symbols spanning all five reels, the game design basically states that any symbol on any position on all reels is a paying combination. That's the same as saying "any position within the reel". A particular symbol on the 1st, 2nd and 3rd reel of the game will be a winning combination as long as there is a matching payment in the paytable. Figure 5 illustrates the "any position" win.

The 243-payline video slot seems to be a natural progression of the five-, nine-, and twenty-payline games and takes into account the most paylines you can add to a game. Changing the rules to allow multiple symbols on a single reel would create even more paylines than our magical "243". This might become confusing to the player, however. Figure 6 illustrates such a funky payline.

In the end, it is possible to see how both IGT and Aristocrat could come up with the 243 payline game or a "243 ways to win" paytable. The issue in the litigation isn't whether it's a natural progression in multi-payline games, though. It's about intellectual property and whether Aristrocrat has protected 243 payline games with their patent. There is the further issue of whether IGT's implementation of the "243 ways to win" is a violation of the patent. Fortunately, this "Virtual World" created in Slot Tech Magazine deals only with math theory. And what can be more fun than math? More math!

- John Wilson
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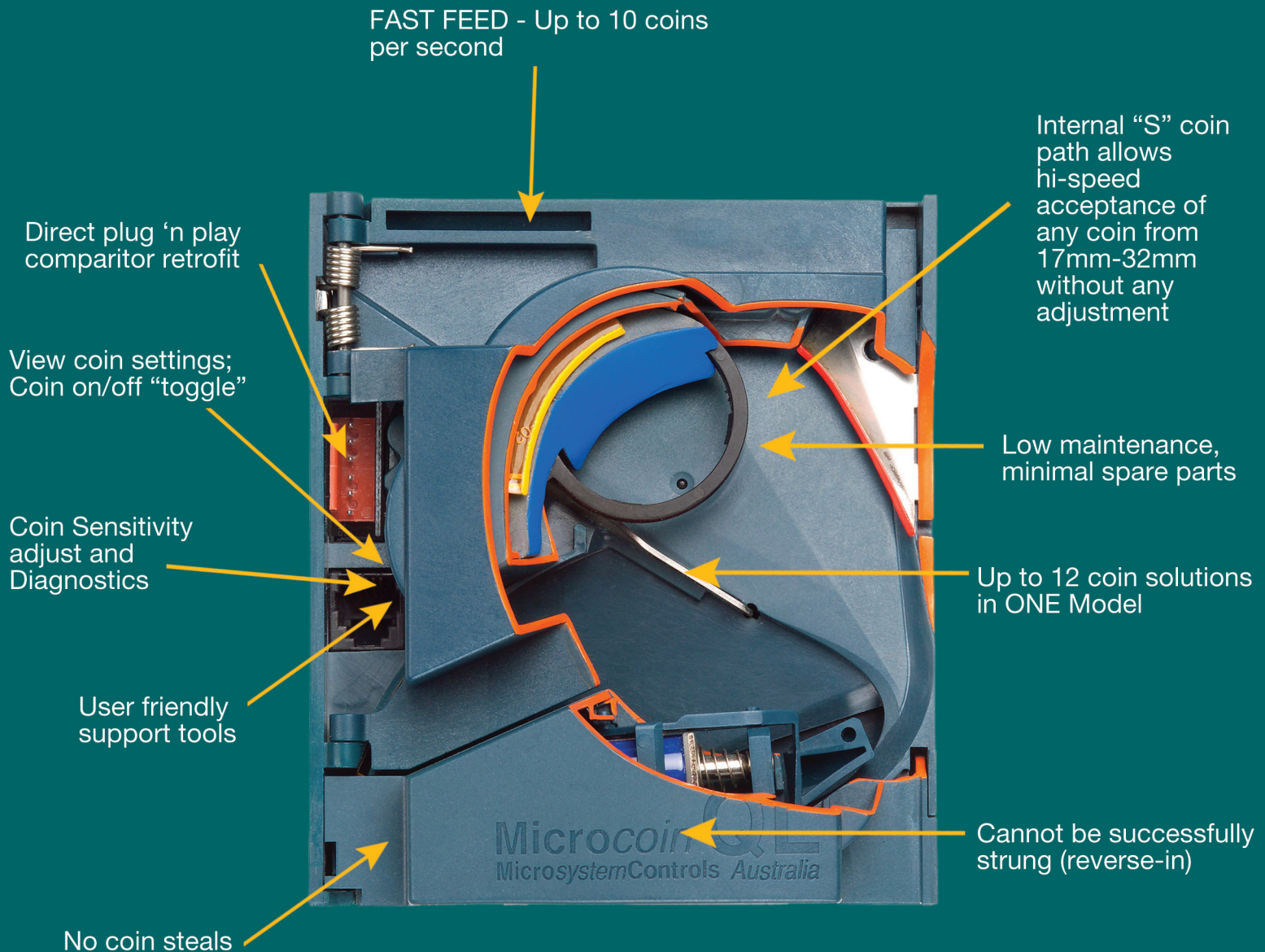[ ] 2 year subscription, domestic
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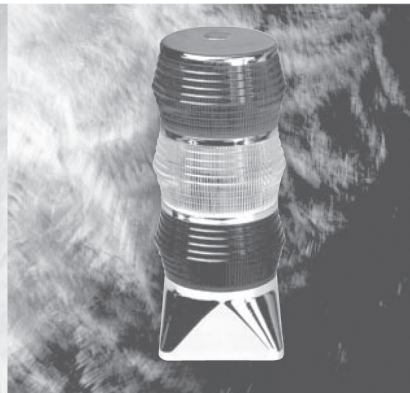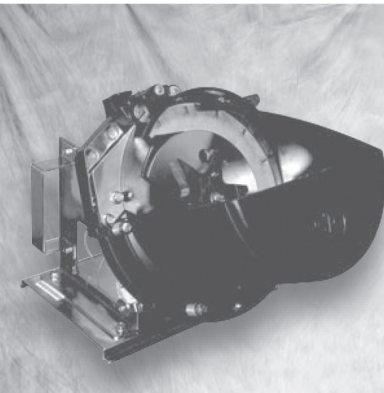# The TOP TEN Reasons IGT™ chose the Microcoin QL as its default small coin unit...

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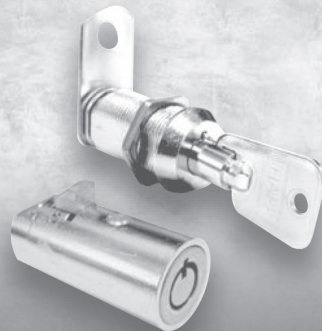**QL Support: 1 866 QL ASSIST**

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