On the cover: Chip In's Island Casino and Resort in Harris Michigan was host to a recent two-week slot tech class, presented by Slot Tech Magazine. At the controls of the official Slot Tech Cessna 172 was Coin Mechanism's, Inc's technical trainer and troubleshooter Michael Harris (right) who joined us for the class. We flew over the casino and took a few snaps.

Attending the event were Jim Randall, Jim Nelson, Pat Porath, Kelly King and Chris Halfaday from Chip In's Island Resort & Casino, Gerald Cadeau and Ed Wright from Ojibwa Casino Resort, John Bivens and James Erickson from Turtle Creek Casino, Norm Cameron and Paul Kosiewicz from Bay Mills Resort, Mitchell Higley and Chris Tucker from Golden Eagle Casino, Corey Cloud from The Lodge Casino and Robert Robinson from Free Play.

Slot Tech Editorial

Whew! It's been a busy month or so for me. In the middle of September, Slot Tech Magazine sponsored a two-week Casino School at Chip In's Island Resort and Casino in Harris Michigan. Sixteen techs attended the class. That's them on the cover, below an aerial photograph of the casino. We had a fun time and fixed a lot of monitors in the process. With an extended training mission like this one, it was good to discover that the casino has a decent restaurant. I was unable to convince them however, that the Pinot Noir shouldn't be stored in the refrigerator.

From there it was home for a week and then off to the Global Gaming Expo in Las Vegas, the first week in October. My show report begins on page 17. Don't expect a lot of in-depth reporting in this issue. The new products and technologies previewed at G2E will be covered in detail in subsequent issues.

Following the G2E, I was off to Illinois for another monitor repair class and a tour of the Wells-Gardner monitor factory in McCook. Like I said "Whew!"

It's time to take our series on test fixtures one giant leap forward with Herschel Peeler's first look at Next Gen test fixtures with multiple I/O and microprocessor control. This is easier than it sounds with the help of a development kit. Next Gen Test Fixture Design begins on page four, including full schematic diagrams for the project.

Are you starting to get the hang of slot math yet? It's not as difficult as you thought is it? This month, you continue to play the part of a slot math wizard in defense of your million coin bonus game in part four of John Wilson's "The Big, the Bad and the Bonus" starting on page 26.

Are you looking for a way to fix monitors without really knowing what the heck you're doing? There are many different ways to approach monitor troubleshooting; different philosophies if you will. Some require extensive electronics background and experience. Others require expensive test equipment. While these skills and techniques often lend themselves to speedy repairs and high levels of productivity, there are times when you just want to get the darned thing fixed and you want to do it in-house. For a sort of philosophical look at a monitor troubleshooting technique that you can begin to use right away (regardless of skill level) turn to "Vertically Challenged" beginning on page 32.

That's all for this month. See you at TechFest 10!

Randy Fromm

Randy Fromm - Publisher

Randy Fromm's
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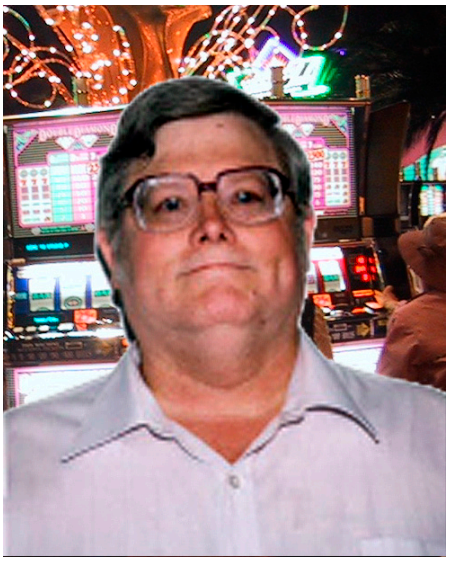


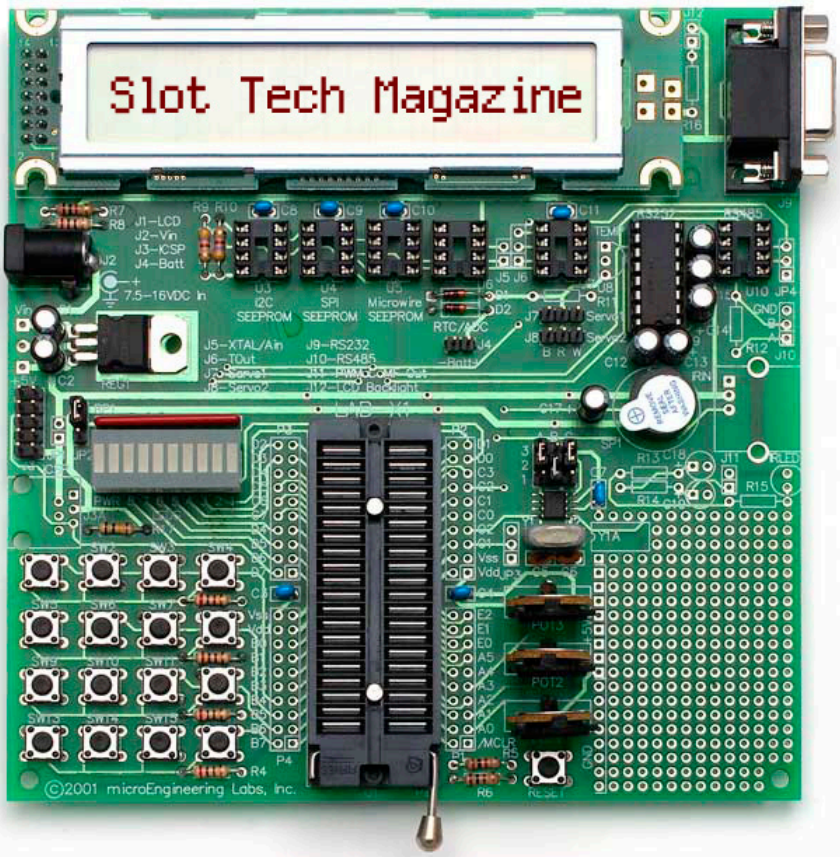
Next Gen Test Fixture Design

By Herschel Peeler

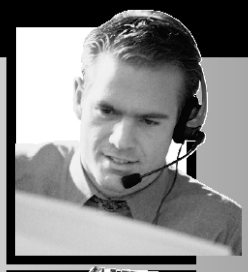
Being under restrictions of not having a gaming device back in the bench area is a pain. In order to test an assembly we must emulate what the game does. So far, the test fixtures we have described have been dumb devices. We controlled things with switches and monitored the outputs with lights. A smart test fixture should emulate what a game does and test it in the same fashion as the game. The dumb testers are acceptable for the most part, but not actually a complete emulation of the game environment. There are things we can't do with the test fixtures we have described.

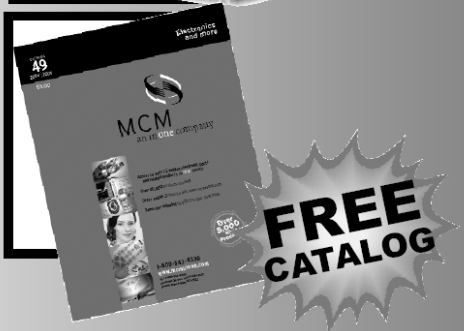
In the game, we have more precise control. Let's take a simple test fixture for example. A Coin Comparator would make a simple first project. We need to monitor two operator inputs on the test fixture to emulate game operation: Enable and Disable. We need to control the coin comparator with one output; Inhibit. When the test fixture sees the Enable button pressed, we want to turn off the Inhibit signal to the coin comparator and watch for incoming coins. When we see the Disable input, we want to turn on the Inhibit input and consider coins coming in to be an error because the coin comparator did not respond properly to the disabled condition.

One of the things we have not done with the dumb test fixtures is measure how long it took for our incoming coin to fall. We could not measure the same Long Coin condition the game can detect. As long as we have the ability, let's measure the fall time of the coin. Another thing we can not readily detect is a coin Double Pulse. It is possible for the Sense coil to be mis-aligned in such a way that we get a null condition



The LAB-X1, part number 169113 from Micro Engineering Labs, has a two-line text display, a 16-button keypad, and abundant I/O.





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two times during a coin insertion - once when the coin approaches the Sense Coil, and a second as the coin leaves the sense coil. As long as we have a display let's display the fall time of the coin and count coins.

The first step in making this test fixture is to design the hardware requirements. We need a microcontroller. Our requirements here are simple. Anything capable of handling a display will do. If we were only looking at two switches and a couple of LEDs, we could do this with a PIC12C509 that has six possible I/O lines. Since we require a more elaborate display, we need something in the PIC16 family with more I/O lines. We want a display capable of test messages. We need at least two button inputs. We need only one Output line. We need two input lines (Coin Sense and Coin Error) coming from the Coin Comparator. This would vary somewhat depending on which coin comparator we were testing. For flexibility to test any coin comparator let's consider a couple of inputs from the comparator and a few outputs too.

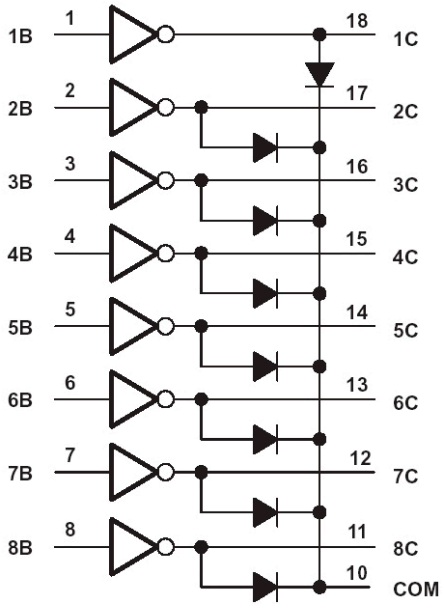
Not being one to re-invent the wheel, we find from Jameco Electronics an already built assembly that does what we need and gives us room to develop to more complex test fixtures. The LAB-X1, part number 169113 from Micro Engineering Labs, fits our requirements. We have a two-line text display, a 16-button keypad, and abundant I/O.

Now that we have our hardware selected, let's see what we need in terms of software. Just as we build our hardware function by function, we build our software the same way, routine by routine. We need a routine that checks for the "Enable" button to be pressed. When it finds "Enable" pressed, it enables the coin comparator, checks for incoming coins, measures the length of the Coin-In pulse, counts the coins, and checks for the "Disable" button to be pressed. If it finds the Disable button pressed, we want to disable the coin comparator. If we detect a coin during this time we want to note that a coin has been detected and flag this as an error because the coin comparator did not respond to the Disable command. This is about what the game software does as far as the Coin Comparator goes.

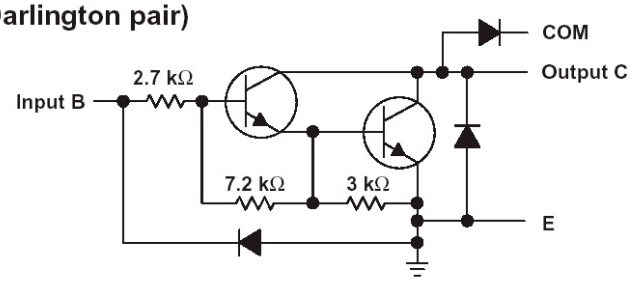
If we want to include Coin-In optics too, we need to check for proper coin direction and check coin speed and time

ULN2803A
DARLINGTON TRANSISTOR ARRAY

logic diagram



schematic (each Darlington pair)



For the test fixure, we have eight possible outputs that we want to be Open Collector. The ULN2803AN is a popular part in the gaming world and we would likely have it in our inventory of parts already.

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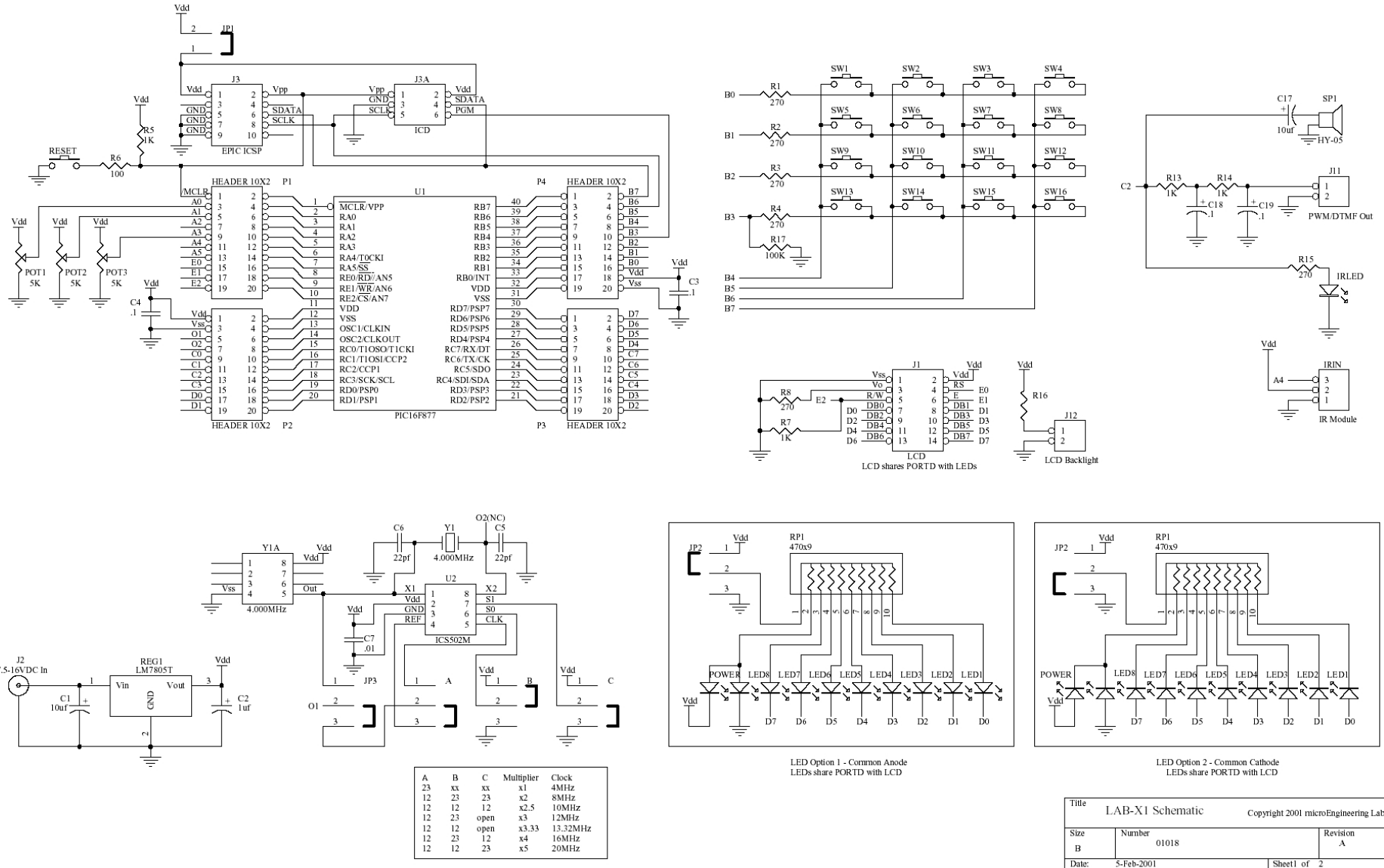

A	B	C	Multiplier	Clock
23	xx	xx	x1	4MHz
12	23	23	x2	8MHz
12	12	12	x2.5	10MHz
12	23	open	x3	12MHz
12	12	open	x3.33	13.32MHz
12	23	12	x4	16MHz
12	12	23	x5	20MHz

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the coin spent passing through the optics. We want to detect Coin-In Reverse condition and Stuck Coin or Long Coin errors. Again, this is about the same thing the game does. Often these operations are included in the coin comparator. To give our test fixture universal application we really ought to include the Coin-In optics.

Hardware Design Details

In specifying our hardware design, we need to specify what we want to do in hardware and design the hardware to accomplish these operations. We take our hardware requirements function by function and specify this in ways that fit our hardware of the platform we chose. The text display is already set for us. We have a sixteen-button keypad in a four-by-four matrix of which we only need to use one four-button section. We have Port A of the microcontroller (six bits) we can use for inputs from the Coin Comparator and Coin-In Optics. We have eight bits on Port D we can use for outputs. The inputs and outputs of the controller are TTL levels so we need to convert the voltage levels from the Coin Comparator and Coin-In Optics to levels that fit the microcontroller. This circuit also serves as a buffer to protect our more expensive microcontroller from potential problems in the assemblies we are testing.

Since we have eight possible outputs that we want to be Open Collector lets use a ULN2803AN for our outputs. This is a popular part in the gaming world and we would likely have it in our inventory of parts already.

For an input side, we want to go from open collector inputs (typical of our gaming world circuits) to the CMOS/TTL voltage levels our LAB-X1 works on. We want to give the same loading of the circuit that is present in the game. Not finding an IC that gives me what I want, I opted for a transistor-based design. This also gave me better protection than I would likely get from an integrated solution. A PNP input matched the open-collector driving circuit. A following NPN transistor matched the TTL / CMOS levels of the microcontroller. This gave general support to a variety of circuits from different games.

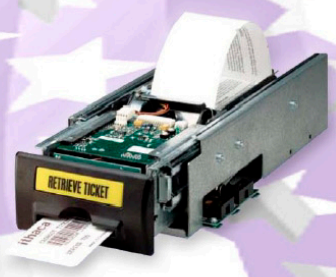
Software Design

In writing our software we detail what we want to do function by function, then express that in the language of the microcontroller we are using.

Our first routine needs to initialize the conditions of the test fixture.
Set our Coins-In count to zero.
Turn off the test fixture.
Disable the Coin Comparator.
Clear the Coin-In Timing count.
Clear any error conditions.
Clear the Coin-In timing display count.
Display a message saying the test fixture is ready.
Watch for the "Enable" button to be pressed.

We need a routine to check a button we have selected to be our "Enable" button. If that button is pressed, we want to do the following:

Enable the Coin Comparator.
Check for an incoming coin.
Check the length of time the Coin-In pulse was and compare that against what is proper.
Check for a Double Pulse coin pulse error.
Display a message indicating how long the pulse was.
Count the number of coins inserted.
Check for the coin to hit our first Coin-In Optic.
Check for the coin to hit our second Coin-In optic (assuming we only have two). Confirming that the coin is going in the proper direction and that both optics are working.
Passing our first optic, we want to start a counter. As the coin leaves the last optic, we want to stop this count.
If either optic is blocked for too long we want to flag a "Long Coin" or "Stuck Coin" error.
If the second optic is blocked before the first optic, we want to flag an "Reversed Coin" error.
Check for coins passing through the optics but not detecting a pulse from the Coin Comparator. Flag this error.
Check to see if the "Disable" button was pressed and jump to that routine if we do.
Go back to checking for an incoming coin.



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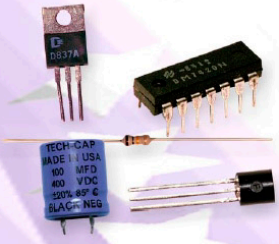
COIN MECHS



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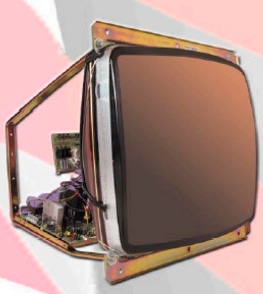

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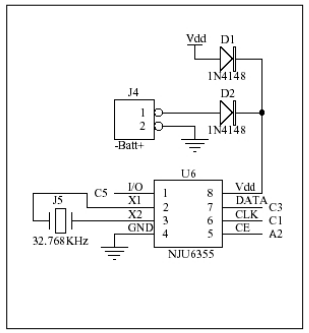
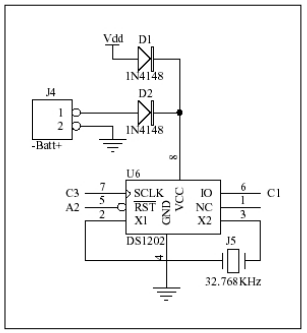
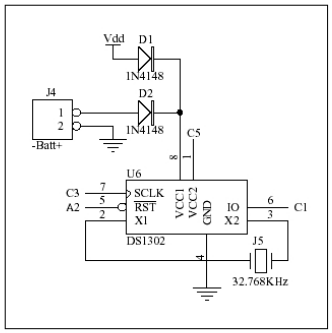


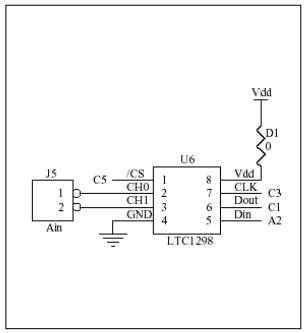
Real Time Clock - Option 1



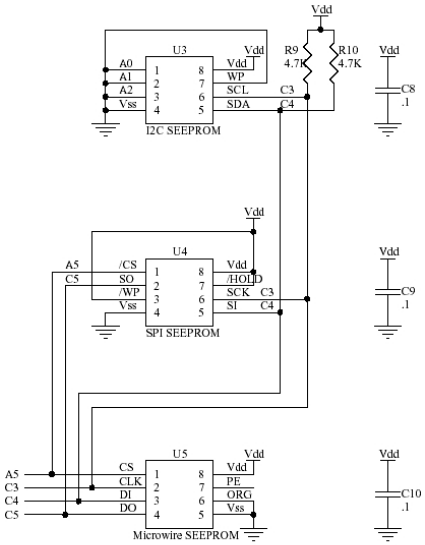
Real Time Clock - Option 2

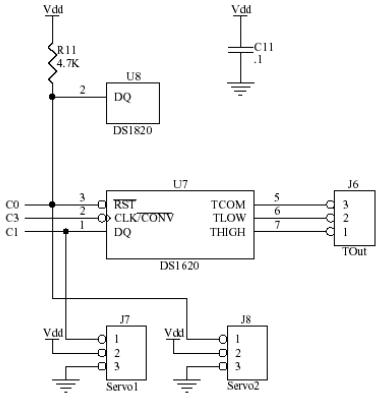


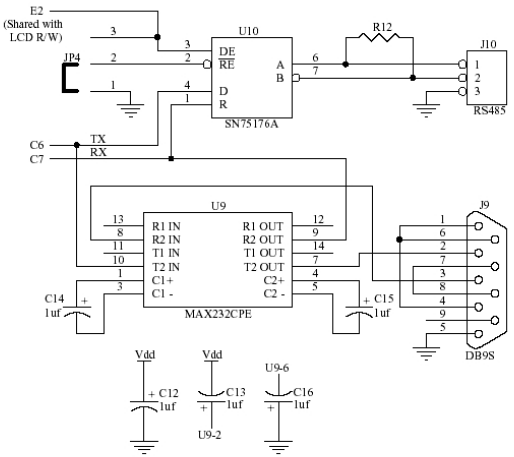
Real Time Clock - Option 3



A/D Convertor - Option 4







Title: LAB-X1 Schematic			Copyright 2001 microEngineering Labs, Inc.
Size: B	Number: 01018		Revision: A
Date: 5-Feb-2001		Sheet 2 of 2	
File: C:\pfwfiles\LABX12.sch		Drawn By: JMS	

We need a routine for checking our "Disable Button". We get to this routine from our "Enable" button routine. In this routine, we want to do the following:

Disable the Coin Comparator.
Check for a Coin-In and flag this as an error.
Check for the "Enable" button to be pressed and go to the "Enable" routine if it is. Otherwise, we go back to checking for an incoming coin.

Now we need to express these routines in the programming language of our choice. The LAB-X1 comes with software that supports both BASIC and Assembly language. Some platforms also support "C" as "C++". We need to write the program in one of these human-friendly languages in a plain text file. Then run this text file through a Compiler or Assembler program that converts the text into machine language (binary) format we download into the microcontroller platform we chose, the LAB-X1 in our example.

The LAB-X1 is not the only platform available, but it seemed to be the best one to write an article about, and use to get our feet wet in smart test fixture development. The LAB-X1 comes as a pre-built assembly. I would suggest this option for your first project. It also comes in a kit form. Future test fixtures can be built using only the features you need and save yourself about half the price

Most every microcontroller on the market has a development board and system comparable to what the LAB-X1 comes with. The PIC family has a rich supply of development boards and available books for education. The BASIC Stamp series is another PIC16 family that is quite popular and is available at a suitable price. All these are available from Jameco also.

If you Google on Freescale, or go to the Freescale website, you will find a Motorola line of microcontrollers built around the MC68HC08, or 908, family. These also have good support and development boards available.

Simpler development boards that do not have a text display or keypad can be found for less than the $200.00 price the LAB-X1 goes for. Jameco has about a dozen other boards for the PIC series of

microcontrollers varying in price from $10.00 up. Once you have a development system in place you can get a second simpler project done for around $20.00.

A General Purpose Smart Test Fixture

Our dumb test fixtures have been built as a variation on a general-purpose theme. This has been deliberate because all along we have been intending to build something smarter. We can build a Four-Input and Four-Output connector for our LAB-X1 that is plug compatible to our general-purpose dumb test fixture and have it plug into them.

If we choose a Flash microcontroller for the LAB-X1 like the PIC16F877 suggested by Jameco, we have a device that is easily re-programmable. The PIC16F877 has sufficient memory for multiple tests. The 16-button keypad and text display gives us flexibility to add a menu system and select from a list of tests for many devices. This is the direction we have been heading in all along.

- Herschel Peeler
hpeeler@slot-techs.com


Alexander Vorobiev

Unicum Opens Office in Yekaterinburg

Unicum Group of Companies, the leading Russian supplier of gaming machines and equipment for the entertainment industry, announces the further expansion of its Russian offices with the opening of a new local office in Yekaterinburg.

The complete Unicum product line will be available in Yekaterinburg office. It will manage sales of all video slots, components and equipment for gaming halls and casinos, machines for entertainment centers and hi-tech management and control systems. Altogether these products cover all aspects of a gaming, casino or entertainment unit.

"All products and solutions which earlier were distributed through the Moscow office, will now be available in the Ural, as well as technical support. We will come, install and launch," commented the head of the new office Alexander Vorobiev. "We are ready to do everything possible to supply our clients with the best products and services."
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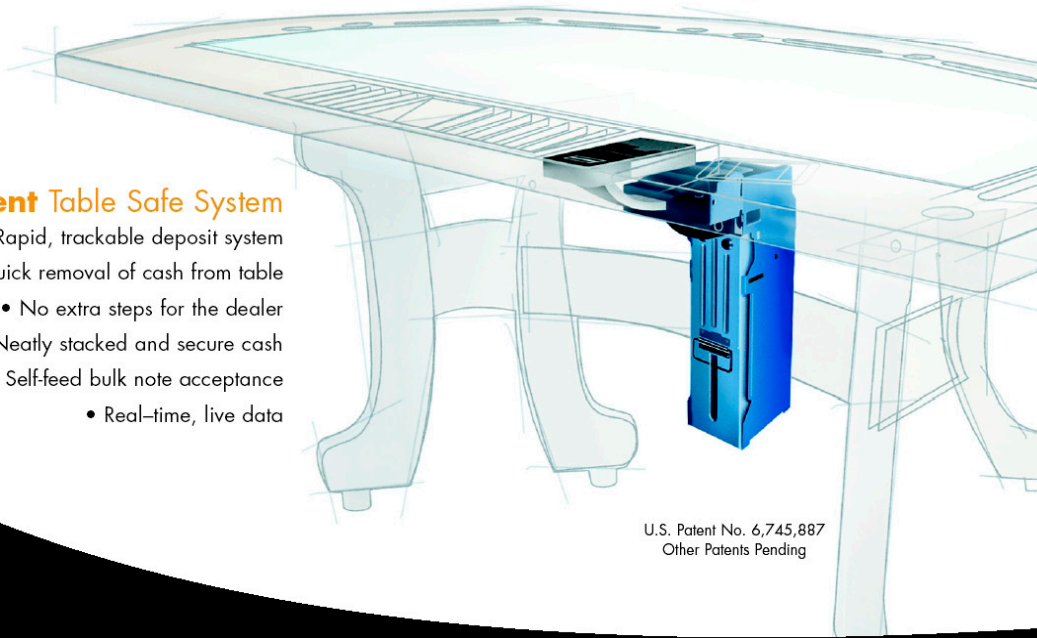

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Slot Tech Event

TechFest 10
Excalibur Casino
Las Vegas, Nevada

The world's largest gathering of slot machine technicians, TechFest 10 will be held in Las Vegas, Nevada at the Excalibur Casino. Dates for the three-day event are November 30 through December 2 2004.

"TechFest is for slot techs of all skill levels," said Randy Fromm, publisher of Slot Tech Magazine and moderator of the TechFest program. We have something for everyone, from novice techs who want to learn the basics of BV and hopper maintenance to advanced techs that need to brush up on monitor repair."

The event features lively and upbeat technical seminars from the gaming industry's leading technical instructors and OEM representatives. Participants include Coin Mechanisms, Inc., MEI, 3M Touch Systems, Sencore, FutureLogic , IDX, Money Controls, JCM and Transact Technologies. There will also be a special presentation on slot math by ICS Gaming and a daily morning session on monitor repair by Randy Fromm.

For more information contact:
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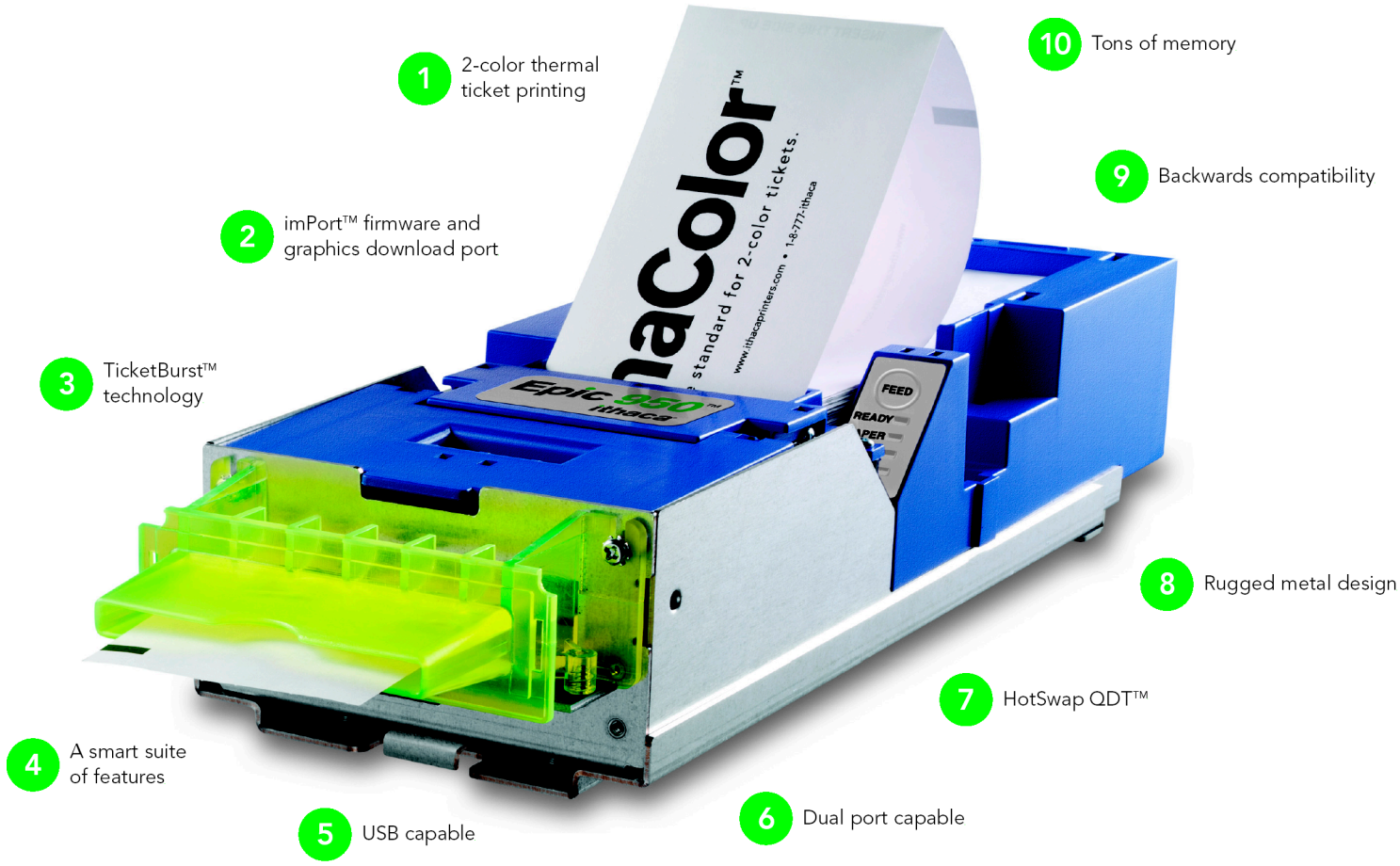
Above: Kanau Sugai and Robert Angell. Asahi Seiko has two new products that will be demonstrated at TechFest 10: A new coin validator and a new, multi-denominational coin hopper.

Below: Casino Careers can help you find a good slot tech for your casino.

Below: At the busy AESI stand with Eric Walla, company president James Brendel, Jackie Wallenburg and super tech Brian Carty.

Below: Paul Hatin from 3M Touch Systems demonstrated a couple of interesting new technologies. One was their Dispersive Signal Technology touchscreen, which was showcased on a 40" display, embedded into a table. The game was Texas Touch 'Em (Texas Hold 'Em) but the demonstration was "all technology" as DST delivers revolutionary touchscreen performance that is unaffected by scratches on the surface. The new touch technology is easily scalable for even larger displays as well. Also incorporated into the table were 3M's proprietary privacy films that prevent players from viewing each other's hands. Two films are used. One prevents anyone standing to the sides from viewing the dealt cards. The other film bends the light by 35 degrees, allowing the player to see his hand without having to lean over the table. Very clever.



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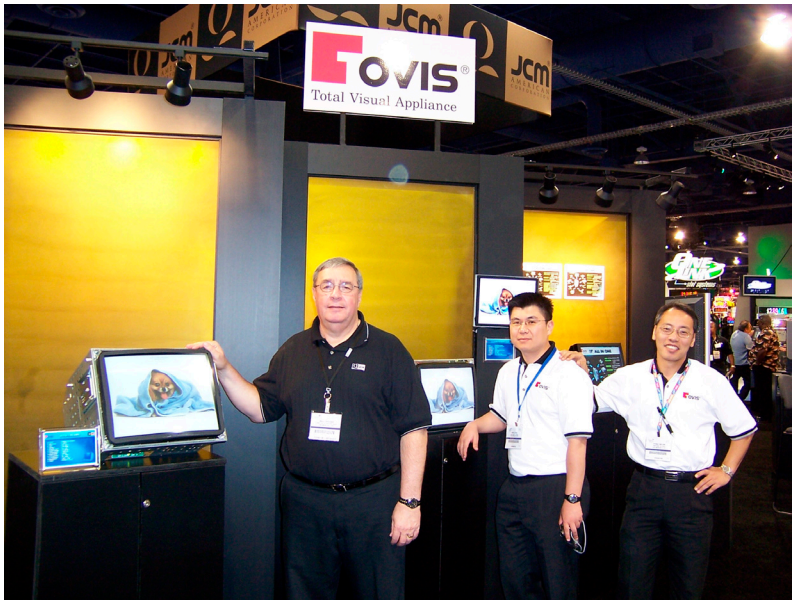
Slot Tech Event - G2E 2004 - The Monitor Guys and Gals

Above: Dave Adams of Aspen Touch Solutions with Ceronix nice guy Don Whitaker

Above: In the Kristel booth with Keith Petri, Ray Holdren, Larry and Kevin Michael



Above: Tovis showed a variety of display solutions. Look for a technical review of their digital monitor in Slot Tech Magazine coming soon. Below left: Slot Tech Magazine publisher Randy Fromm at Kortek. Below right: Jennifer Hart and Kimberly Van Veen of Casinotech.

Above: Pentranic's Harry Clarke holds their new digital chassis. Assembled in UK, this is a very nice monitor that is worthy of attention.

Below: Joe Tontodanato, Tony Spier and Bob Lube of Wells-Gardner Electronics.

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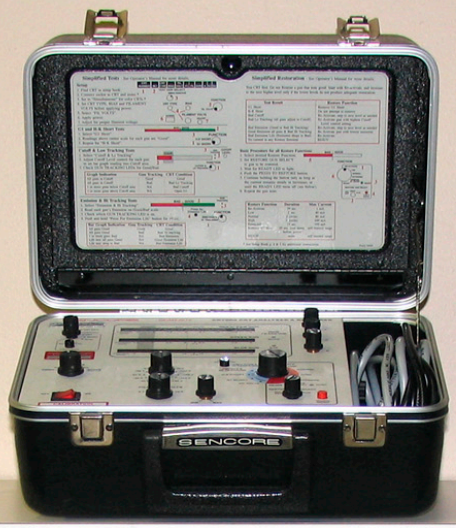

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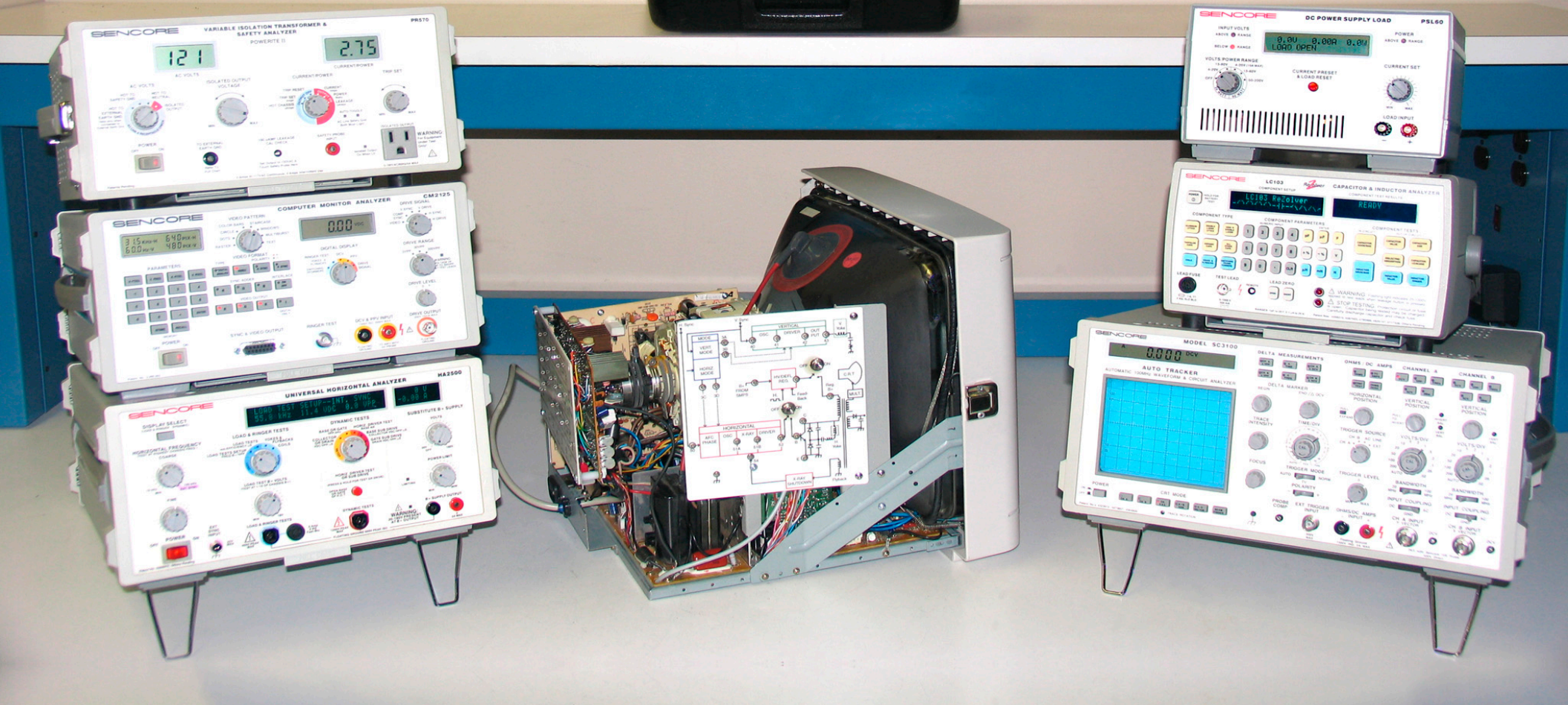

Slot Tech Event - G2E 2004

Above: CI Innovations showed their cold cathode lighting system.

Below: Cashcode's Marlon Silver and their super currency bundler machine.

Below: Patron Saint of Slot Tech Magazine, Frank Happ (l) with his son (and new company president) Tom Happ (r). That's Ralph in the middle.

Peter Boyd-Cumins demonstrated the ASSA replaceable core lock.

Above: FutureLogic's Nick Micazelli

Below: MCM wants to help your slot techs with the tools and equipment they need for electronic repair.

Medeco showed their high-security locks. That's Michael Kennedy, above.

Above: Denny Salmella showed off Transact Technologies' new Ithaca Epic 950 printer.

Left: Jack Geller and Dan Peterson - JCM

Below: I had a very interesting conversation with these guys about monitor test connectors and cables. That's Kiesub's Jim Koziol (l) and Jim Wegg.

Above: Austrian Gaming Industries' Wolfgang Duralacher chats with Astrosystems' Robert Bird about their Microcoin validator.

Above: Randy Fromm's pick of the show for "Most Frightening Slot Topper" Below: Comedian Drew Carey drew a big crowd at his themed game at IGT.

Drew Carey

The company name is Coin Mechanisms, Inc. but their product line includes not only their popular Coin Comparitor and their latest "Defender" coin validator but slot machine buttons and other controls as well as their cold-cathode slot machine lighting system as featured in last month's Slot Tech Magazine. From the left is Product Manager George Hoehne, Western Regional Sales Manager C. Greg Ramirez and company founder and president Stanley Pierz.

The happy, smiling folks from IDX. You can always count on these folks for a warm welcome. IDX was showing a range of products including their secure "X Mark" token system and IDX "Xceptors."

JCM Announces UBA Bill Acceptor

Plastic Cashbox Retrofitable to Existing WBA Units

The UBA bill validator builds on JCM's world-famous world bill acceptor (WBA), with improved bill-sensing technology and lightweight, durable plastic construction. This one unit can accept all of the world's currency up to 85mm in width without any hardware changes and can hold up to 500 notes. The UBA comes complete with the latest sensing technology, utilizing magnetic and optical sensors. Infrared, red and green LEDs, phototransistors, UV, reflective, transparency and bar code sensors comprise the UBA's optical sensing package. The UBA also features forward and backward compatible cash boxes for seamless integration onto your slot floor.

Convenience

*Automatic centering mechanism centers notes in the middle of the bill path regardless of how the bill was inserted. This allows for a greater first time acceptance rate because the bill is directly in the middle of the head when it is scanned. Centering also eliminates the need for additional bill guides in the entry bezel and cash box.

* The automatic retry feature will re-scan a bill up to three times before rejecting. This greatly increases the acceptance rate.

* The USB download port is located in the front of the unit for easy accessibility. It allows for quick and easy program downloads without having to remove the unit from the game.

* Communication between the game and the validator can be achieved through the USB port in the rear of the unit, or the same standard connection as the current WBA can be used.

* Plastic cash box is manufactured from a high impact, highly durable plastic that resists damage and is backward compatible with all WBA units that are currently in the field. There is also a viewing window that allows the last bill stacked to be seen without having to open the cash box.

* The UBA is the same size as the current WBA and mounts in the same fashion. The front bezel mounting configuration remains the same as the WBA as well.

Security

* The anti-pullback roller device prevents "stringing." The device has interlocking teeth that eliminates the ability for somebody to pull a bill back through the entry.

Sensing

* Improved sensing technology makes use of magnetic and optical sensors to validate the currency.

* Optical sensing consisting of infrared, red and green LEDs, phototransistors, UV, reflective, transparency and bar code sensors.

* Accepts currency from multiple countries at the same time without having to change validator software.

For further information, contact:
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www.jcm-american.com

TechFest 10 - Excalibur Casino - Las Vegas, NV - Nov. 30 - Dec. 2, 2004

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

TechFest 10 will be held November 30th through December 2nd, 2004 at Excalibur Casino Hotel in Las Vegas, Nevada. Registration fee for TechFest is $450.00 per person and includes lunch each day.

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

BE A BETTER SLOT TECH

- **Coin Mechanisms, Inc. - Coin Comparitors**
- **MEI - Bill Validators**
- **3M Touch Systems - Touchscreens**
- **Sencore - Test Equipment**
- **FutureLogic (formerly Seiko) - Ticket Printers**
- **IDX - Coin Validator**
- **Money Controls - Coin Validator/Coin Hoppers**
- **JCM - Bill Validators**
- **Ithaca - Ticket Printers**
- **Microcoin - Coin Validator**
- **Asahi Seiko - Coin Validator and Hopper**
- **WMS Gaming - Bluebird and CPU-NXT (also legacy systems Q&A)**

Bonus Session - Slot machine creation, Bonus Games & PAR Sheets - Slot Math made fun and easy - presented by John Wilson
- PLUS - A special instructional series on video slot monitor repair presented each morning by Randy Fromm

Come and spend 3 days at TechFest. With engineering and technical representatives on hand from the gaming industry's leading suppliers of touchscreens, bill validators, coin comparitors, hoppers and monitors, YOU have a chance to ask about YOUR problems. You have a chance to get REAL answers to your questions, face-to-face with some of the most qualified technical experts in the industry.

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

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

Space is limited - Register today!

Part 4

The Bonus

The Big, The Bad and

By John Wilson

Driving down the highway to work, Larry is at your side. You've spent a lot of time together these past few weeks working on the bonus game. Larry turns to you and says "You know, the hardest part of this entire project was getting the direction on how the game has to pay. Once we worked out a rough plan on what we could pay, and how frequently, the rest fell into place."

"I agree," you reply. "The pay schedule the board proposed just wouldn't work. We could pay out those large jackpots but it was a little bit unrealistic. After all, we're talking about a quarter game. I think the payouts we finalized are pretty impressive, just the same."

"Quite so. When you mentioned converting this into a 5-coin multiplier, I knew you had found the missing piece. It just gave us so much room to work with, that we could tweak the numbers into some realistic awards."

"But you have to admit, Larry.

"On behalf of Table Mountain Casino I just wanted to express our thanks to you and your team. I couldn't have asked for anything better."

Brian Rankin - Slot Technical Manager

On-Site Slot Tech Training
Customized Classes Available

Randy Fromm's Casino School is a practical, no-nonsense look at how gaming machines work and how to repair them when they don't. **No previous knowledge of electronics is required** to get the most out of the school. The Casino School is geared for those who want to learn how to fix gaming devices without having to learn complex electronic theory or purchase expensive test equipment.

Be prepared for six hours of accelerated learning each day. Class begins at 9:00 am sharp each day and continues until 4:00 pm. The Casino School provides each student with reference materials and troubleshooting guides that will be valuable aids for repairing equipment on location and in the shop.

Students learn how to work with:

THE DIGITAL MULTIMETER

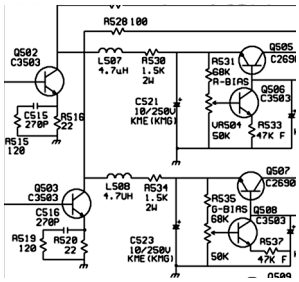
This relatively inexpensive piece of test equipment is easy to operate. Casino School students learn to use the digital multimeter to perform tests and measurements that will pinpoint the cause of a failure down to a single component.

ELECTRONIC COMPONENTS

The individual components used in games are introduced. Parts such as resistors, capacitors, diodes, potentiometers and transistors are covered individually. Students learn how the components work and how to test them using the meter.

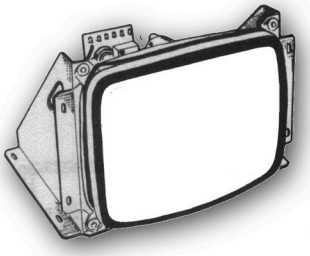
SCHEMATIC DIAGRAMS

Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



POWER SUPPLIES

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.



MONITOR REPAIR

The monitors used in video slots are designed for quick, easy, and safe repair. Students will learn the theory of operation of all types of monitors and how to repair monitors down to the component level. Of course, monitor safety will also be discussed.

You do not have to send your slot techs to Las Vegas or Atlantic City for training. The Casino School brings the training to you. Contact Randy Fromm's Casino School today to reserve a date for your tech school

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The real genius is in your interface to the marquee. That brings it all together."

"It's really not technologically advanced, though. It's only using displays that have been used for years."

"Perhaps, but not how you have implemented them. It's genius! The top award of $1,000,00 only pays with max coins played. Each of the awards, all 14 of them, change depending upon coins wagered. That helps our math but your display makes it art. The LED displays are wonderful. Play one coin, the top award is one-fifth of the maximum. The bonus display shows it as $200,000. Every amount changes dynamically based upon coin in. There's no confusion for the players, and no worries for the casino or the gaming commission. WYSIWYG!"

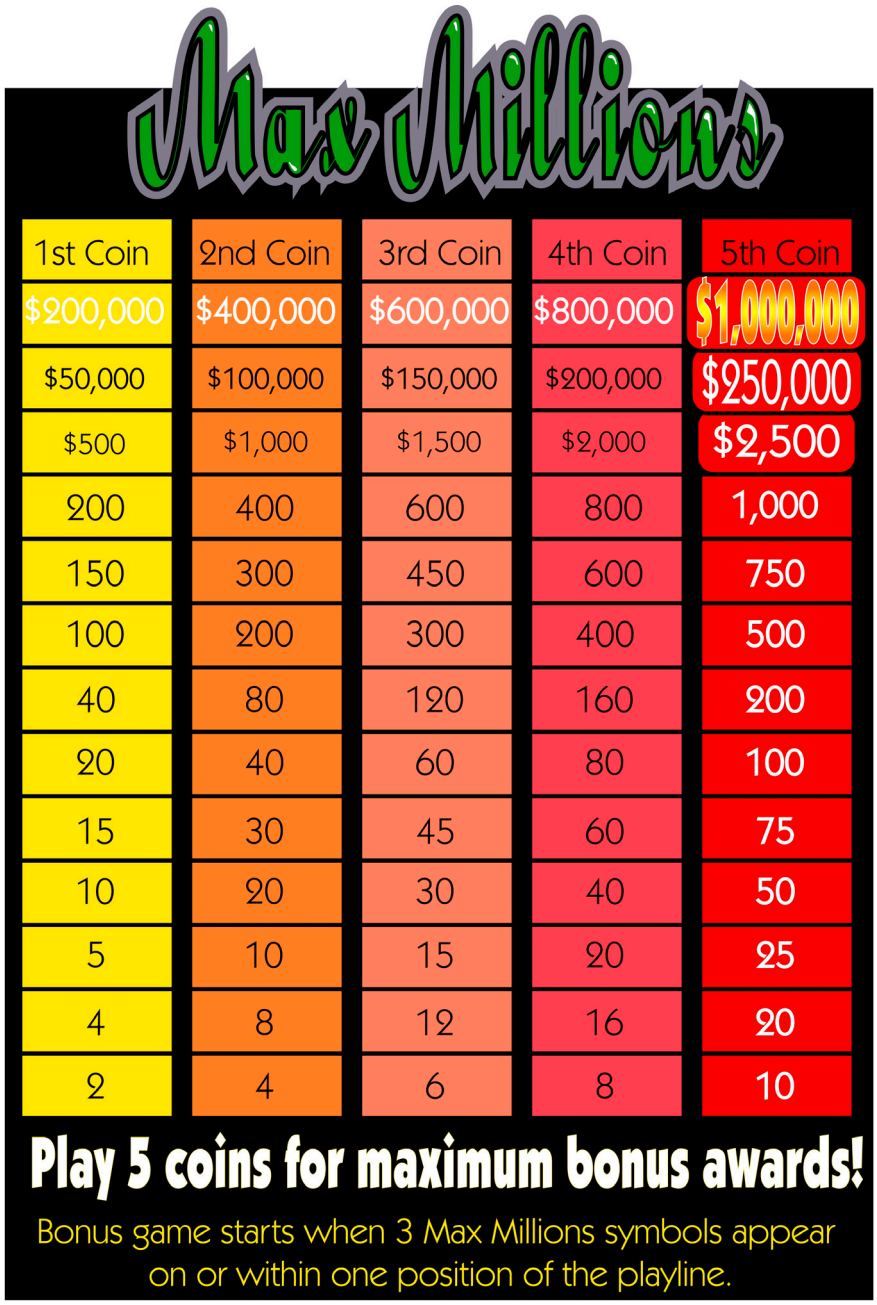
"What you see is what you get, yes indeed. I think the board will like our updated demo CD. You did an excellent job reproducing my marquee. It looks very true to life. If I may say so myself, I think changing the LED colors during the bonus game makes it more interesting."

"Well, after all of the work we did, I really think we'll come out of this meeting with final approval from the board. I don't think we'll be looking at any more changes to the design." [You pause, but no eerie organ music plays.]

Within a few minutes, you're turning off the Parkway and pulling into your parking spot. Yes, today's the day that ICS Gaming puts its bonus game into development!"

When you enter the boardroom, everyone is assembled around a laptop computer. You see them examining the CD simulation of the Max Millions game. You chuckle to yourself, wondering what they're going to think of the new & improved version. The real-time statistics should give them complete confidence in the development. Of course, not everyone likes studying game statistics, but it will be fun for them just the same.

Larry has gone down to the lab to hook up his prototype marquee. It will give the board an actual visual representation of the finished product. It's going to hook into a Blazin' 7s game and although it's not pretty to look at, it's pretty impressive to see!



"I know that you have all had a chance to look at the bonus CD we distributed at our last meeting, and I will have a newer one for you today. Larry and I have completed the bonus game math and we have a few demonstrations for you. I'm going to cover the payout, math, integration of the bonus game and the simulation on the updated CD. Afterwards, we'll head down to the development lab, where Larry is putting the final touches on a prototype we've been working on, so that you can see the bonus game work in an actual machine. Before I start, does anyone have any questions?"

The Marketing VP starts by asking, "Last week you mentioned a 5-coin machine. You talked a bit about the payout per coin. I think I understood what you said, but I wondered if you could just review that before we get into the final plans. Perhaps you didn't even go that way, so if not, please proceed."

"We did actually work with the 5-coin multiplier. However, not in the way we discussed last week. I will explain how it fits into the 5-coin platform, and that should answer your question."

The Marketing V.P. nods his head and smiles.

"As you're aware, a key element to getting the bonus game to work is to determine the average payout from a single bonus game. We look at all of the possible bonus game outcomes, add up each of the awards, and get the average. We had looked at a 200-coin average. The problem was getting a small cycle that would realistically give us this 200-coin average quickly. We studied this and came up with a slightly better version. We determined that every coin could qualify for the bonus game, not just the top coin. However, the math required to do this also encourages max-coin play, which is good for the casinos. We only pay the $1,000,000 award on max-coin play. As you'll recall from the chart we showed you last month, the average payout was actually reduced to 188.2625 coins. For each lesser amount, the jackpot is adjusted, or prorated, if you will. Take a look at this chart."

Everyone Gets A Chance

As you can see, a player wagering five coins can play for the $1,000,000 jackpot. However, a player using only one coin is still eligible for the bonus game, but the top award is one-fifth the amount, or $200,000. A 3-coin player plays for three-fifths of the

top award, or $600,000. We think this will add to player satisfaction. If they only play one coin but happen to get the bonus game, they still get to play the game, but just get a smaller award. It keeps the accounting nice and easy, because all of the percentages are geared to numbers of coins played.

While the average bonus game may pay 188 for 5-coin play, it will only be 38 for single-coin play. You pay out less, but you take in less, too. This way, the bonus game is a multiplier bonus-game, and not a buy-a-pay bonus game as we had considered before. In order to facilitate the changing awards for the bonus game, Larry has come up with an LED marquee that dynamically changes the amounts. Whenever the player starts the bonus game, the values shown on the marquee represent what he or she can actually win, based upon number of coins wagered. It keeps things very clean and removes player confusion. This will be shown on the next CD you'll receive.

Take a look at this next image. Here we see two bonus games. The one on the left has been started with a 1-coin wager, while the one on the right has resulted from a 5-coin wager. The players know exactly what they can win, even before the bonus game starts to run.

We're on PAR

"I think it's a good time to review the PAR sheet for the bonus game, which will answer the question about average payout. Before I do, are there any more questions?"

The CEO and the VP of Game Development are quietly conversing, and in a moment, CEO speaks. "Your example of the varying payouts is really great! Personally, I think that's what we've been looking for. I have a thought about the way that we could use this, but I think I'll wait until the end of your presentation to bring it up. It might mean a slight change in the bonus game, or it could mean we come out with a second bonus game. I'll have to think about it for a few minutes."

You show the summary sheet of the bonus game PAR sheet and wonder just what plans they might have.

As you can see, we have summarized the bonus game, just as we do for the base games. This summary looks very similar to the one we had created for the standard Blazin' 7s PAR sheet.

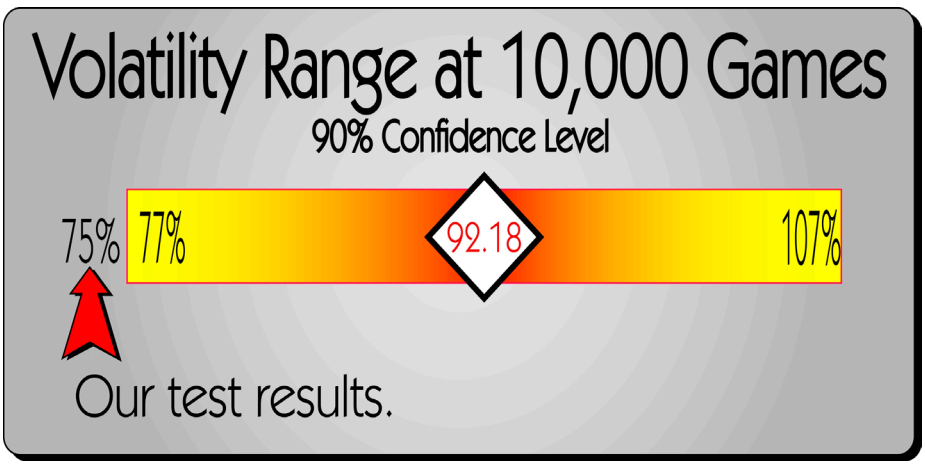
The original Blazin' 7s game had 64 stops per reel. We've expanded to 72 stops in order to allow for additional winning combinations. The base game cycle, 373,248 games, calls the bonus game 3,840 times. The bonus game will occur, on average, every 97 games. That means that a player wagering one coin at a time on $20.00 of credits has a very good chance of obtaining the bonus game. The low-roller player can still take advantage of this game. It will offer a wide appeal to many types of players.

Trial Run

During some initial testing, we had players try the game and they liked it. We put the base game through 10,000 spins to get a feel for some 'reel life' play. We also analyzed 100 bonus games to see how it behaves. Let's talk about the base game first.

After 10,000 games, our payout percent was 74.89%. This is 17% lower than the theoretical payout. The hit percent was 1.4% higher than expected at 12.88%.

The V.P. of Marketing inter-



rupts. "How does this fall into our expectations? We're a little bit away from normal, is this ok?"

Well, we do have a range of expected results based upon the volatility index. At 10,000 games, we should fall between 77.43% and 106.98%.

He asks, "We're below the range. We should be at least 77%. What does that mean? Does the game not work? Are our calculations incorrect?"

"No, not at all." you answer. "The range shows expected results based upon the volatility of the game. Remember the statement '90% confidence level'? This means that we're 90% confident that the results will fall within this range. Sometimes it won't. Ninety percent of the time, however, it will. Because the game is based upon a random number generation, it's going to vary from theoretical. Being a bit outside of the range is not a problem. If we ran this test four more times, I would estimate that each of these four tests would fall within the expected range. If none of them did, we might have a problem. As it stands, we're well within the statistical 'norm'. At 1,000 games the payout was around 102%."

The maximum win during the bonus game was 1,000 credits, with the minimum being 10. The average payout was 77.8 credits. As we didn't have the top award, we expect the average to be lower than predicted. The minimum payout was received 14 times, or 14% of the games. That means that the player received more than the minimum award 86% of the time. This was a major factor in player satisfaction. The players all noted that they were happy to receive more than the minimum. Although 80% of the games will pay 50 credits or less, the players are happy when they receive 20 credits, because it means that they didn't come in last place.

The bonus game, during our trial, came up every 85.3 games. We calculated that this should be every 97 games. We're 12% off, but for a small sample run, this again is well within what we expected. The shortest time the bonus game started was four games, and the maximum was 342 games.

"Does that mean that someone played 342 games before the bonus game came up and someone else only played 4 games? That can't be right. At 342 games, that would be $427.50 put into the machine before the bonus game came up. You say that this is normal, but I'm not sure I can see how," asks one of the V.P.s

"Remember that the PAR sheet I showed you a few moments ago explains how the game plays in theory," you respond. "Since we pick the outcomes randomly, there is a variance. How much of a variance depends upon a number of factors, like the number of stops per reel, the number of outcomes in a cycle, etc. All of the games, both ours and the competitors', have this variance. Double Bars should come up every 280 games, according to our theory. This is on average. There must be times when the double bars comes up on sequential games, and other times when it doesn't come up for 380, 480, perhaps even 750 games. The payouts on the Max Millions bonus game are affected in the same way. Although there is a one million dollar top prize and a $2.50 bottom prize. The average is $47.07. Some will be higher, some lower. The same applies to the calculations in the PAR

Volatility Index

# Games		Upper Range	Lower Range
100	146.57	237.76	-55.39
1,000	46.67	138.86	45.52
10,000	VI=14.76	106.95	77.43
100,000	4.66	96.85	87.52
1,000,000	1.47	93.66	90.71
10,000,000	0.46	92.65	91.72
100,000,000	0.15	92.34	92.04

sheet. We're looking at averages, so there will be some variance."

"I see. That's why the payout range you showed us with the volatility index changes with more games played? At 1000 games, the payout is really wide. At 10,000 games, there's a narrower range. At one million games, the range is pretty small. But even then, as we've seen, our results can still fall outside of the range we've determined."

"Exactly. Statisticians refer to the 'sample population' to indicate how many of a particular item they are looking at. With a small sample population, perhaps 1000 games played, the results vary widely, and might not be accurate enough to really work with. At 10,000 games, we still have a relatively small sample population. It's certainly enough to give us a good idea about what results we'll see, but there's still not enough games to make a solid prediction."

"So how do you predict the results on the PAR sheet?"

"We look at every possible outcome in the game. We examine them all and give the results. Basically, it takes the entire range of possibilities and gives you precisely accurate results from a perfect world. The game cycle of 373,248 games will give you every possible outcome that you can receive, and every outcome will be examined once and only once."

"Right. So after 373,248 games, our results should match the PAR sheet results pretty closely. Except that random numbers means that one combination might come up twice and another one might not have come up at all."

"Yes. That gives us our variance."

"If we get the million-dollar award right away, our payout percent would be, well, quite high."

"Actually, it would be 80,000,000 percent. Quite high. But, after a complete cycle, if we hadn't yet paid out the top award, we'd be looking at a payout percentage roughly 4.4% below our predicted value."

All of a sudden, the CEO gets a worried look. He stands up and exclaims, "Oh, no! This isn't right. We've made a big mistake somewhere. What are we going to do?"

"What's wrong?" you ask.

"Your PAR sheet. It can't be right. You show the cycle there - with payout percentage. The total coins in is 1.8 million, and the coins out 1.76 million!"

"Uh, right. That gives us 92% of coin in paid back out to the player."

"That's right. But the bonus game pays out four million credits. We aren't taking that into account. We take in 1.8 million, but we haven't paid out the bonus. That would mean we pay out 4.76 million coins plus the other bonus amounts. Oh, no. Tell me that I'm missing something. The bonus game pays out 7.5 million coins, doesn't it? This explains why our test results came up outside of the range in the Volatility Index calculation." She sits down, shakes her head, and looks down at the table. Silence fills the room.

Did our dynamic duo miss something? Is there a mathematical faux pas? Is this project really doomed? Was the problem changing to a $1,000,000 jackpot really just foreshadowing a tragic end?

Tune in next month . . . Same magazine, same boardroom.

We'll also have our Max Millions simulation ready for download when the December issue comes out. Consider it our holiday present to you!

- John Wilson
jwilson@slot-techs.com

Vertically Challenged

This story begins and ends on day seven of the recent Casino School tech class that was held at Chip In's Island Resort and Casino in Harris, Michigan. It was one of our hands-on lab days during the second week of the class. This is the fun part of the two-week class because we finally get to perform repairs on the bad monitors that the students have brought with them. These were real failures from the participating casinos and we had tons of 'em. We fixed the overwhelming majority of them as well, using the simple techniques that we had covered during the first week of the class.

The mantra is simple:

Learn about the components themselves and how to test them using a digital multimeter or other simple, inexpensive meter or testing device.

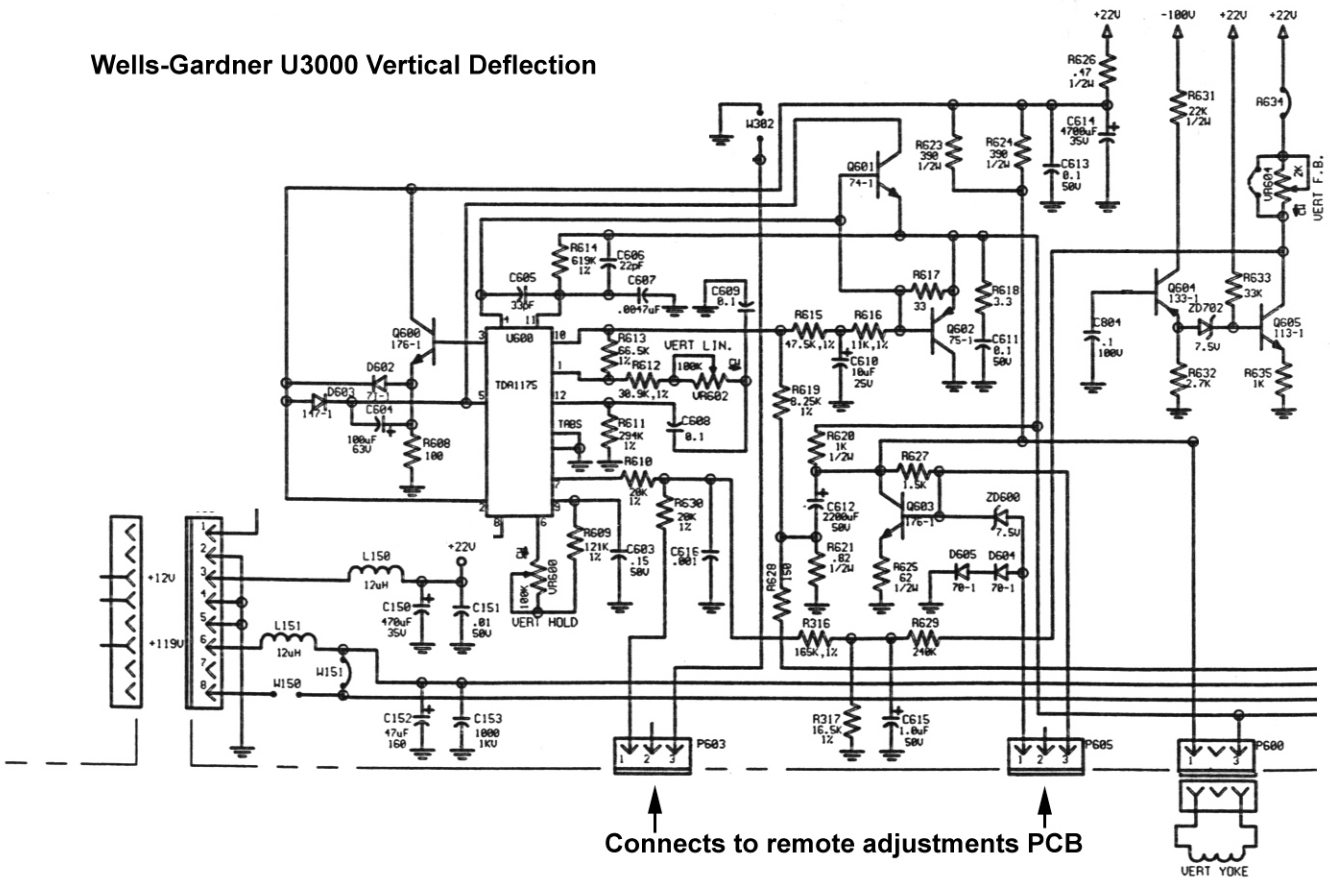
Learn the basics of how the circuits operate and how to identify which components are in the circuit that's giving you trouble.

Combine the two skills to test the suspect components and locate the defective part.

That's all there is to it. Without learning a whole lot about electronic theory and without a speck of math, you're well on your way to repairing monitors.

Oh yeah . . . One more thing. Learn to solder. PLEASE. My friends at Wells-Gardner generously donated a big box of fully populated monitor PCBs to the class for soldering practice. The idea was to practice on these junk boards - they were factory fall-outs or unrepairable customer returns - and butcher them instead of damaging a PCB during an actual monitor repair. Despite this, we experienced more than a few hours of lost time as inexperienced technicians worked up a sweat over bad soldering techniques. Not their fault, of course. It takes more than a single afternoon to develop good soldering skills.

However, soldering skills were not an issue for the repair under discussion here. In this case, the team working on this Wells-Gardner U3000 monitor had all the soldering skills needed for the job. This was a simple repair: total loss of vertical deflection. The all too familiar symptom was, of course, a single,

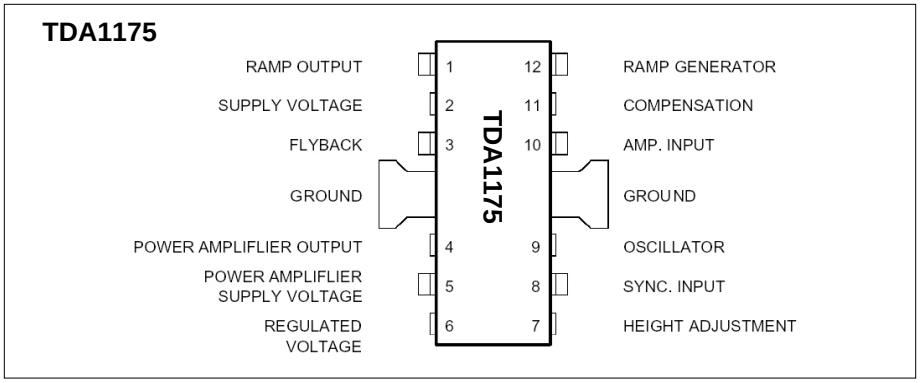


horizontal line, precisely bisecting the screen.

This vertical design uses a TDA1175 to drive a pair of vertical output transistors. Initial troubleshooting for the vertical deflection circuit is generally the same, regardless of the design. The first question to ask is "Do I have power to the circuit?" In this case, you can see that pin 2 of the TDA1175 is the power pin. A glance at the schematic and you can see that it's connected to the +22 VDC power supply. With power applied, the voltage at pin 2 was measured. It was good at 22 volts DC. If it had been missing, we might have suspected that R626 was open as it's in series with the +22 VDC power line. Likewise, we would have suspected the TDA1175 itself as being bad. Typically (not always) when the series resistor opens - That's how resistors fail. They open circuit - they fail because the IC has shorted, drawing too much current across the resistor.

Well, in this case we also suspected the TDA1175 as being the cause of the problem. Not because the resistor was open. (It wasn't. Remember?) but because we simply couldn't find any other bad components. We tested the vertical output transistors. They tested fine. We replaced a couple of capacitors that had a slightly increased ESR but we sort of knew that wasn't going to fix a total loss of vertical deflection like this.

The IC was replaced (not an easy job with a "findip" package that has a finned, copper heatsink attached to it; the heat from the soldering iron is sucked out as fast as you can put it in) by the team's most skilled technician. Everything was plugged back in (the deflection yoke, second anode and remote adjustments



PCB) and power was applied. The moment of truth turned into sucking defeat. There was still no vertical deflection. The symptom was exactly the same as before. Or was it?

Not exactly. The original symptom was a single horizontal line, right across the exact center of the screen. After replacing the IC, we still had just a single horizontal line but it was no longer in the middle of the screen. It was now about three inches above the centerline. The symptom had changed.

Any change is significant when you've replaced a component. The fact that the line had moved above the centerline means that there is now a DC bias on the vertical deflection coil in the yoke. Other than a tiny bias for raster centering control, DC is not something you normally see on the deflection coil.

So, what can we infer from this? The logical inference is that the TDA1175 wasn't actually bad and that in the process of changing it, WE DID SOMETHING to the PCB. We lifted a solder pad or broke a trace or left a little solder bridge or something. In this case however, the replacement was made properly. We examined the PCB with a powerful magnifying glass (and even a jeweler's loupe) and verified continuity with a meter.

The next most logical inference is that we had missed the bad part when we tested the transistors, diodes, etc. At this point, it was getting late in the afternoon and what had first seemed like a simple vertical deflection repair had somehow degenerated into something a bit more complex and challenging. I told the team to knock off for the day and that I was going to return to the classroom after dinner and pull out the big guns. I was gonna pull out (drumroll, please) THE 'SCOPE. Yessireebob. I was going to attack this problem like a REAL technician and use the host Casino's Sencore SC3100 Waveform Analyzer oscilloscope to perform some honest-to-goodness professional troubleshooting. Actually, I was really looking forward to it as I rarely have the motive and opportunity to use the oscilloscope for monitor repair. Most monitor problems are easily diagnosed using just a digital multimeter and a capacitor ESR meter.

After a delicious prime rib dinner at the casino restaurant, I set things up on the bench. The first thing I wanted to do was to familiarize myself with the circuit and the waveforms that were supposed to be present at various test points. To do this, I pulled a working U3000 that we had already fixed and fired it up. DO NOT OVERLOOK THIS IMPORTANT RESOURCE. You're in a casino. You ALWAYS have more than one of each type of monitor. I put Kraftwerk's Ultra Rare Trax on the Walkman and got down to it. Basically, I hopped

around the pins of the TDA175 and looked at the waveforms. I wasn't really trying to interpret them so much as simply get a handle on what they looked like on the oscilloscope.

Then, I fired up the bad monitor and looked at the same pins. On the input side, I seemed to have the oscillator pulses but the output of the chip was dead. No vertical ramp generation at all. Could the replacement IC be bad? That is always a nagging possibility when troubleshooting and you can just beat your head against a problem for hours before changing a component for a second time. I poked around for about 20 minutes with the oscilloscope at which time I had not really progressed much beyond the profound diagnosis of "it's broke."

Time to take another tack. Time to pull back from the world of the oscilloscope and enter the magical realm of A/B comparison testing. I have two monitor chassis in front of me. Except for the fault, they are identical. With the power turned off and my meter set to measure resistance, all I have to do is measure the resistance across each component. Note that I am not necessarily testing the component. I am not even trying to interpret the reading in any way. I am just looking at the number on the meter as I move from the good monitor to the bad monitor, measuring across each component in turn.

Naturally, I don't want to have to do this for every component in the monitor. I want to measure across only those components that have something to do with vertical deflection. Most monitor manufacturers have adopted a simple but effective way of telling us which parts do what in a monitor. Each of the different circuits in the monitor (power supply, video amplifiers, sync, vertical deflection, horizontal deflection, etc.) will have its own part number series. Power supplies might all be the "100s." The video might all be "500s." In this case, all of the vertical deflection components are the "600s" as you can see from the schematic diagram. I only have to measure across the 600s and there aren't that many of them.

Actually, I began by using my meter on the "diode test" setting in order to measure at the pins of the TDA1175. I grounded my black meter lead to the chassis and probed each pin with the red meter lead. The two chassis were identical. Although this is not a functional test of the IC, when these ICs fail, they often show a much lower reading than normal on one or more pins. Since the two ICs test exactly the same, I concluded that the IC was likely not the cause of the problem.

I then switched the meter to read resistance and proceeded, as described above, to measure the resistance across each of the "600s." Some of the components were a bit difficult to locate on the board but within a half-hour, I had found and measured across each one and found absolutely no differences between the two monitors. I was convinced at this point that we had no bad components on the PCB and the problem must lie elsewhere.

I tried my known-good chassis on the CRT/yoke from the bad monitor. The yoke wasn't bad (I had already measured its resistance so I didn't expect it to be bad.).

That only left one thing: The remote adjustment PCB. I carefully measured the resistance of every potentiometer on the remote PCB and checked their continuity through the ribbon cable to the connector at the end. They were all fine.

And then it hit me. It hit me like a ton of bricks. Each time I removed the monitor chassis and the remote PCB in order to test components and make measurements, I was very careful to replace the connectors exactly the way they came off (always a good idea). The U3000 has a couple of 2 pin connectors that lead to the remote PCB that can be interchanged if you're not careful. The same is true for the remote adjustments PCB. It isn't keyed and can be connected upside down.

By process of elimination, it all came down to a simple mistake. The original problem had been located and repaired in under an hour. The TDA1175 was bad. In reassembling the monitor, the connector to the remote adjustments PCB had been inverted, leading to a symptom that mimicked the original loss of vertical deflection but with the little twist that the horizontal line was biased above the center of the screen.

My point in all of this is not so much "Don't plug stuff in the wrong way" but rather to give you a method of finding all types of tricky problems without really knowing what you're doing, technician-wise. Once you're armed with a basic understanding of the components themselves, all you really have to do is grab a good thingy and compare it to your bad thingy. The differences (or in this case, the lack of difference) will usually be obvious.

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