

MARCH, 2002

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Slot Tech Magazine
is an official publication of G2E



March marks a couple of important milestones in the history of Slot Tech Magazine. This is issue number twelve. Just a year ago, I was contacting everyone I knew in the gaming industry to ask them if they saw a need for a magazine that would address the technical issues of slot machine service and repair and, more importantly, if they would support such a magazine through subscriptions and advertising. Their response was one hundred percent positive and Slot Tech Magazine began pub-

lishing in April 2001. That premier issue is now out of print and available for free download at the slot-techs.com website.

I would like to express my gratitude to all of our subscribers and advertisers for their support. I would also like to thank and to congratulate Slot Tech Magazine's contributing writers for their excellent contributions to the magazine. There is an extraordinary wealth of technical information contained in these first twelve issues, none of which is boring to read. It's all lively and personable stuff. Kudos to all. I am proud of what we've accomplished together in this first year.

I am likewise proud to announce that Slot Tech Magazine is now an official publication of the Global Gaming Expo. The success of G2E is a phenomenon in every sense of the word and their recognition of Slot Tech Magazine as a bona fide representative of the technical side of the gaming industry is well received.

In other, related news, the American Gaming Association (AGA) and Reed Exhibi-

tions, which together own and produce Global Gaming Expo, announced their acquisition from GEM Communications certain assets of World Gaming Congress & Expo. This means that WGCE is dead and that there will be just one show this year, as predicted by just about everyone in the gaming industry. The event will continue to be called G2E.

G2E 2002 is scheduled for Sept. 17-19, 2002, at the Las Vegas Convention Center. More than 250 exhibitors already have signed up for the show, including all of the industry's major manufacturers. IGWB and Casino Journal, two GEM publications, will join Slot Tech Magazine as official publications

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

Randy Fromm
Randy Fromm



Randy Fromm's Slot Tech Magazine

Editor

Randy Fromm

Technical Writers

Bart Holden
Ken Locke
Kevin Noble
Herschel W. Peeler

Advertising Manager

Dennis Sable

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published monthly by
Slot Tech Magazine
1944 Falmouth Dr.
El Cajon, CA 92020-2827
tel.619.593.6131
fax.619.593.6132
e-mail

editor@slot-techs.com

Visit the website at

slot-techs.com

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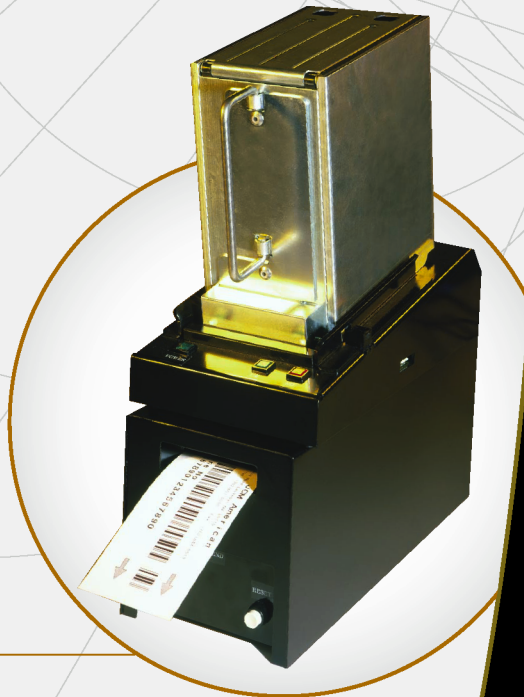


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Europe

JCM Germany GmbH,
Büttgenbachstraße 5, D-40549 Düsseldorf
Tel: +49.211.5306450 **Fax:** +49.211.53064565

www.jcm-germany.com
email: info@jcm-germany.com



Developing Your Inner Slot God

By Bart Holden



Nearly every occupation, sport, or hobby has certain fundamentals detrimental to achieving maximum output. In basketball, one must be able to pass, catch, dribble, rebound, and shoot the basketball while also possessing the ability to defend. Likewise, being a slot technician also requires certain fundamentals. I'm not talking about electronic prowess or the ability to strip down a slot machine and rebuild it blindfolded. Let's face it, you don't have to be able to slam-dunk a basketball to be a good player. It certainly helps if you want to be a professional but it's not necessary.

Generally, slot tech managers hire individuals who possess the basic fundamentals required to become a slot technician. These skills may include the ability to use tools, a general knowledge of electricity or electronics, some body strength for relocating slot machines, and the common sense required to take apart assemblies and successfully rebuild them. However, there are other skills that can make the average slot technician a better one. Perhaps the equivalent of a pick and roll in bas-

ketball, these skills not only help the individual but significantly impact the slot tech team. I want to talk about the little things that take an extra second or two that we neglect from time to time.

I realize that this is a technical magazine that is read for the most part by working slot technicians. You may be asking yourself why you should read such an entry-level article. I could answer that you're already a fourth of the way through the article so why not finish? However, the better answer is that you may be neglecting some secondary skills that can increase the productivity level in your shop.

LABELING PARTS

It is difficult to overemphasize the importance of labeling bad parts. I have been guilty of walking into the shop with a bad power supply, placing it on the bench, and promising to return from the restroom to repair it. The radio crackles to life with a floor call and before I realize what has happened, the day is over. Inevitably, the power supply finds its way back into the good parts cabinet and weeks later, I'm slinging explicatives because I have installed a bad part that was mixed with the good ones.

Of course, it was my fault. Someone was cleaning the shop and found an unlabeled power supply on the bench and took a fifty-fifty chance

at whether it was good or bad. They assumed it was functional and returned it to the parts cabinet.

Manila tags and tie wraps are all that is needed to tag bad parts. All one has to do is write down a date, the machine number, a general description of the failure, and maybe your name or initials in case someone has a question. It is also a good idea to designate an area in the shop for placing bad parts until they can be repaired or shipped for repair.

MAINTAINING A CLEAN SHOP

It has been proven that a neatly organized, clean work area is directly proportional to the quantity and quality of work an employee accomplishes. Scheduling cleanup days is a good way to maintain a clean shop. However, the best way to keep a shop clean is for each employee to take responsibility for his or her own mess.

There are parts on slot machines that can't be repaired. These parts belong in the trash once they are broken yet it is not uncommon to find broken switches, buttons, hopper knives, and agitators lying around many shops on workbenches and floors. Disposing of throw-away parts is a key ingredient in keeping your shop organized. It also helps to discourage other clutter from piling up in the work area such as paper, used tie wraps, tech manuals, and

other garbage.

I have found that empty boxes and slot cups are magnets for trash. It seems to be human nature to see a box or cup and throw old optics, extra hardware, burnt out lamps, decals, and other slot items inside rather than in the trash can or provided bins. Keep the cups on the casino floor if at all possible and cleanup days will be a lot easier.

HAVE FUN

I am very fortunate to work for a casino that promotes fun. I'm not exaggerating when I say that I would probably be terminated for having too much fun sometimes if I worked anywhere other than The Isle of Capri.

After reading Frank Sutter's article in the April 2001 issue of slot tech magazine

titled "The Ambassador, the Slot Tech and You", I always think of slot technicians as one of the most vital employees on the casino floor. For the most part, we get to meet the customers when they are already angry. Their machine was super hot before it broke and we are there to put it on ice. I used to think that it would be best not to joke with even a mildly angry guest. However I have found that I have the ability to turn their negative attitude into a positive one by having fun.

It rarely takes much effort. First, my exaggerated Southern (nearly hillbilly) accent convinces the customer that I am a harmless good ol' boy. Occasionally, I jokingly tell the guest that if the machine keeps paying like it is, I'm gonna have to throw it in the Gulf of Mexico. Of course they know this isn't true and

usually laugh hysterically. Other times, I choose to use my Irish, almost leprechaun appearance, to convince the guest that I will sprinkle some lucky dust in their game before I leave. The results are always great. I haven't received one complaint and best of all, the next time I encounter the guest they call me by name and are much less defensive.

These are only a few of the secondary skills that help us to be standout technicians. I'm sure our readers have other tips that we could all use to fine tune ourselves. I would enjoy receiving your feedback and ideas that could help me, my fellow technical writers, and all of our readers become more than just slot technicians but *great* slot technicians.

- **Bart Holden**
bholden@slot-techs.com

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Cheat Sheets

(my extended memory)

By Kevin Noble

Have you ever had problems remembering what the options of a particular manufacturer's game are, how a specific option is supposed to be set, or even the differences between a stand-alone progressive, link progressive, or just a normal game?

When I was working at the large Commercial Casino, one of the slot technical managers started assembling a small, 6" binder full of information about which BV EPROM version went with which game out on the floor in order to prevent mistakes. He eventually took the book further in adding such information as IGT options, tests, meter charts, procedures for sets and clears and calibration procedures out on the floor, to name a few. He started to add such equipment as Jet Sort option settings for wrapper codes.

This was a great book to reference any material or refresh your memory to complete your task. This was even better than getting sheets of paper with this information printed on them. Most people just throw them

in their lockers and they never see the daylight ever again. At that time, "the book" was considered part of your tool belt and was to be carried at all times. Needless to say, it did not matter how small it was; it was still considered big and bulky. It would not fit in your tool belt, and if you tried to stick it in your front pocket, the pockets would start to rip.

When I moved to a smaller Casino, I took this concept and started to apply it, yet scaling it down ever further. It started with small pieces of paper with the option setting for an individual game. In time, the papers became thicker so we had to staple them together. Then they would start to rip, tear, fade and curl on the ends. The concept was good; it fit in your pocket, you could check any manufacturer's options, and if a RAM clear was necessary, the options could be set exactly as in the beginning. In time, we discovered that the office staff had a laminating machine upstairs along with the sheets of laminate. Cool! We started to laminate these sheets and they lasted a long time. We typed them out on the com-

puter small enough that each one was pocket size. Then they started to get bulky again with more and more different manufacturers, game types, reels, and now video.

We then took it to the next step. Let's do one manufacturer, label all the option numbers and then, down each column, list the game type and how the option should be set. This was the greatest thing since sliced bread. One card had two manufacturers, and four or five different game types depending what was set on the floor. If you remember the procedure to do the clear and sets, half the battle was done. We did not have to open the game beside it and go over each option one-by-one and you did not need another technician to open the other game.

To help others who were not doing the clears all the time, we made a point form of procedures for them. We used the Commercial Casino's idea, simplified it to have more information, made it smaller, made it last longer and you could carry the cheat sheets in your front pocket.

Many of the technicians started securing slot attendant pouches to the back of their tool belts now. These mainly held all of our sheets for options, clear/set procedures, Cage & Coin equipment without running back to the tech shop, or bothering another technician who might be tied up with something else. We also used this concept for when we do upgrades, moves, or when new machines arrive on the floor.

We started printing the options on the machine inspection sheets for each manufacturer so when the option was set correctly, the technician checked off the box marked "option set." All the information was right at their fingertips. Our service reports and meter sheets all have the meter information for all of the manufacturers so there are no mistakes. You can skip the numbers you don't need and you do not have to fumble through notes. There are many different manufacturers and programs now. If you don't use it all the time, you forget how to use it. This is just a little helper that I call the "cheat Sheet".

Figure 1 shows us the option settings typically used out on the gaming floor. We use all the IGT programs on this sheet. The option of the game is in the left column. Next comes the game type being

IGT REELS						
	G	P	C	M	W	A
				2	2	2
				1	1	1
	1	1	1	0	0	0
2	0	0	0		1	0
3	1	1	1		1	1
5	0	0	0	0	0	0
6	0	0	0	0	0	1
7	1	1	1	1	1	1
8	1	1	1	0	1	1
9	1	1	1	1	1	1
1						
0	0	0	0	0		0
1						
1	0	0	0		0	0
1						
3	1	1	0	1	1	1
1						
6	1	1	1	1	1	1
3						
0	7	7	7	7	7	7
3						
1	0	1	0		3	
3						
4	0	1	0		0	
3						
5	1	1	1		1	
3						
9	1	1	1		0	1
4						
3						0
5						
8						3
5						
9						3
6						
0	0	1	1		1	
6						
3	0	0	0			
6						
4	0	0	0			
7						
8						0
11111101 MINI DIP SW						

FIGURE #1

BALLY REELS					
	G	S	P		
27	1	1	1		
26	1	1	1		
9	6	6	6		
10	DENOM (DIP SW)				
11	1	1	1		
2	0	4	4		
7	0	1	1		
18	0	0	0		
80	0	0	0		
1	0	0	0		
47	1	1	1		
38	0	0	0		
48	7	7	7		
50	0	0	0		
54	0	0	0		
56	LOCK-UP AMT				
62	0	0	0		
78					
H		1	1		
78L	0	1	#		
4	0	0	0		
51	LOCK-UP AMT				
3	0	0	0		
70	0	0	0		
71	0	0	0		
72	0	0	0		
58	LOCK-UP AMT				
59	0	0	0		
6	0	0	0		

FIGURE # 2

used. The "G" stands for a normal game, "P" for link progressive, "C" for the car link, "M" for Mini-Bertha progressive, "W" for Wheel of Fortune, and the "A" for the Anchor games. The Bally reel card has the same meaning as the IGT, but we added the

“S” for a stand-alone progressive. If you notice in figure #2, it’s about the same size so that when it is cut out and laminated, it is laminated on the backside. This again is to save space. These are just examples of the kind of cards we are currently using. We also have them for clear/set procedures, programming Mikohn signs, downloading animation, IDX programming, last bill and game recalls, and accessing meters for all manufacturers, just to name a few. The different option settings are usually highlighted in red just to draw attention to a change. Again, these are just examples of the cards we are currently using. I could have put up the Williams reel and video, IGT and Bally video, Sigma, and so on. You can design your own style type sheets that will work for you and your technicians the best.

OVERVIEW

Given the chance to help technicians simplify their tasks and duties is one way that I can make a difference for the betterment of my fellow techs. In this case, it’s by preparing sets of step by step instructions for all kinds of procedures and settings all on small cards for easy referencing. No more faded or torn sheets, no more big and

bulky binders, no more running to the shop to look up information in the manuals, and no more bothering other technicians or embarrassing yourself about skipping a procedure or setting an option wrong. This has been a rewarding experience for me, when others are left to repair, inspect, and diagnose problems using their cheat sheets. Slot supervisors will reference the sheets that you created for bill disputes and last game recalls, and new technicians will have a reliable set of notes on hand to help install confidence. In time, like everything else, once you do it over and over and it becomes etched into your brain, you rely on it less and less but I guarantee that when more machines and

manufacturers become available to you, you will dip into your pouch or front pocket, look up what you second guessed, set the option correctly and then follow down your list until you have reached the end, like I have done millions of times and will continue to do so.

I hope this will help everyone one else and bring ideas to your department to make the technician’s job a lot easier. The possibilities are endless. If you have any ideas that could make my job easier, you can drop me a line at Slot Tech Magazine and I can pass them along to others in another follow up edition in the future.

- Kevin Noble
knoble@slot-techs.com

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Meet Roman Czubak

Technical Support - Austrian Gaming Industries

Hi Randy!

Congratulations on your new magazine - well, it may be not so new anymore, but it's new to me. I've convinced my boss to subscribe to it.

My job in Novomatic is Technical Support in the widest sense of that word:

- Installations of new machines
- Service of old machines of all Novomatic types
- Technical training on site and in Austria
- Telephone support - advice etc.
- Spare parts ordering
- New equipment support (implementation of new bill acceptor types etc.).
- Small casinos accounting
- Licensing, etc.

I live now not far from Vienna, in a little town called Traiskirchen. I'm constantly travelling all over, so there are times when I live in my suitcase.

I've missed you at the G2E in Vegas. Are you going to be in London at the ICE? Maybe we will have a chance to meet there. I'll be at the Novomatic / Austrian Gaming Industries stand, just pop in whenever you will have a chance.

Thank you!

Best Regards,

Roman Czubak
Technical Support
Austrian Gaming Industries

Hotline: +43 2252 606 300
Fax: +43 2252 607 001
www.austrian-gaming.com

Editor's note: Obviously, we managed to hook up at ICE. Roman is a very good technician whom I first met when he was one of my students. He was working for Carnival Cruiselines at the time. I am trying to convince him to write about Novomatic machines for Slot Tech Magazine.



Who said that slot techs can't look good while they're on the job? Roman Czubak takes a moment at the busy ICE show to pose next to Novomatic's Moneypoly [sic] video slot.

Nifty 50 debut

The need to manage customers' win expectations lies at the heart of Nifty 50, a dedicated £25 machine which was launched by Project at ATEI.

With some sectors of the UK market expressing their concern that £25 may actually serve to disillusion players due to the reduction in hit frequency, Project has responded with a simple play machine which offers the opportunity to win £25 followed by a repeat chance of a further £25.

Project MD Tony Boulton explained: "The response that we are receiving from speaking to arcade and bingo operators is a shared concern that machines may become tougher for customers to play following the introduction of the £25 jackpot. Nifty 50 caps the win opportunity in a very obvious way to two £25 wins which, we believe, addresses the concerns and effectively manages players' expectations."

New hand for Joker Poker

Joker Poker, the joint initiative between Project Coin and Deith Leisure, is now avail-

game play depending on the profile of the customer-base.

Tony Boulton, Project managing director explained: "The mid-tech version allows players to gamble every win up to a maximum of £25 whereas the lo-tech, which is most suited to the bingo sector, allows the player to gamble only when she or he wins with a Joker. This results in a greater number of lower value wins." He added: "The ability to select the style of a game by simply using a dip switch allows operators to make independent re-tailing decisions, as well as delivering the versatility to move machines between locations which have different player profiles."

According to feedback from operators, Joker Poker is making sig-

nificant headway in helping to broaden the player base, with evidence from bingo halls showing that a significant proportion of Joker Poker customers are new or lapsed AWP players.

able in two interchangeable game formats, both with £25 jackpots.

The initiative gives operators the opportunity to select between mid- or lo-tech style



Gaming Management Courses Offered by UNR

Courses offered in Reno, Las Vegas and San Diego

March 3-8 in Reno "Promotional Strategies for the Gaming Industry" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, March 3 from 5:30-7:30 p.m., Monday-Thursday, March 4-7 from 8:30 a.m.-4:30 p.m., and Friday, March 8 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

March 4 in Las Vegas "Advanced Slot Math and Bonusing" - A one-day gaming management program offered jointly by the University of Nevada, Reno and the University

of Nevada Las Vegas. Held Monday, March 4 from 8:30 a.m.-4:30 p.m. at UNLV, International Gaming Institute, Stan Fulton Building, Las Vegas. Course fee: \$289, includes instruction, course materials, lunch and refreshment breaks.

March 5-6 in Las Vegas "Getting the Most from Your Information Systems: A Guide for Non-IT Gaming Managers" - A two-day gaming management program offered jointly by the University of Nevada, Reno and the University of Nevada Las Vegas. Held Tuesday-Wednesday, March 5-6 from 8:30 a.m.-4:30 p.m. each day at UNLV, International Gaming Institute, Stan Fulton Building, Las Vegas. Course fee: \$525, includes instruction, course materials, lunch and refreshment breaks.

March 27 in Reno "Cage Department Operations and Management" - A one-day gaming management course offered by the University of Nevada, Reno College of Extended Studies. Held Wednesday, March 27 from 9 a.m. to 4 p.m. at the university's Continuing Education Building, 1041 N. Virginia St., Reno. Course fee: \$125.

April 10-11 in Reno "Risk Management and Liability Issues for the Gaming Industry" - A two-day gaming management course offered by the University of Nevada, Reno College of Extended Studies. Held Wednesday-Thursday, April 10-11 from 8 a.m. to 5 p.m. each day at the university's Continuing Education Building, 1041 N. Virginia St., Reno. Course fee: \$210.

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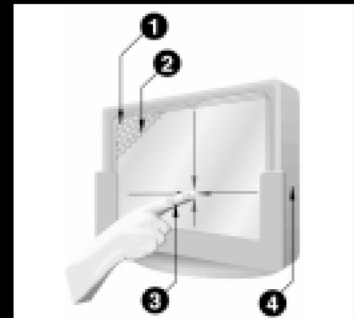
- Over 90% of all touch gaming machines rely on MicroTouch's capacitive touchscreens, worldwide.
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- Based on extensive field experience, there's negligible maintenance required and less machine downtime with MicroTouch touchscreens.
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MicroTouch — Keeping you in the know.

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How ClearTek Capacitive Touchscreens work



Voltage is applied to the screen (1) and the electrode pattern uniformly distributes the low-voltage field (2) over the conductive layer. When a finger touches the screen (3), it "capacitively couples" with the voltage field, drawing a minute amount of current to the point of contact. The current flow from each corner is proportional to the distance from the corner to the finger. The controller simply calculates the flow proportions to locate the touch (4).

April 22-23 in San Diego, preceding the NIGA 2002 Convention "Linking and Leveraging Your Player Tracking System: An Interdepartmental Approach" - A two-day gaming management program offered in San Diego preceding the NIGA 2002 Convention, by the University of Nevada, Reno College of Extended Studies. Held Monday-Tuesday, April 22-23 from 8:30 a.m.-4:30 p.m. each day at the San Diego Concourse. Course fee: \$525, includes instruction, course materials, lunch and refreshment breaks.

May 5-10 in Reno "Financial Accounting, Analysis and Auditing" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, May 5 from 5:30-7:30 p.m., Monday-Thursday, May 6-9 from 8:30 a.m.-4:30 p.m., and Friday, May 10 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

May 14 in Reno "High-Tech Fraud in the Gaming Industry" - A one-day gaming management course offered by the University of Nevada, Reno College of Extended Studies. Held Tuesday, May 14 from 9 a.m. to 4 p.m. at the university's Continuing Education Building, 1041 N. Virginia St., Reno. Course fee: \$125.

June 9-14 in Reno "Surveillance Operations and Management" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, June 9 from 5:30-7:30 p.m., Monday-Thursday, June 10-13 from 8:30 a.m.-4:30 p.m., and Friday, June 14 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia

St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

July 21-26 in Reno "Management of Slot Operations" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, July 21 from 5:30-7:30 p.m., Monday-Thursday, July 22-25 from 8:30 a.m.-4:30 p.m., and Friday, July 26 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

August 11-16 in Reno "Advanced Surveillance Operations and Management" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, Aug. 11 from 5:30-7:30 p.m., Monday-Thursday, Aug. 12-15 from 8:30 a.m.-4:30 p.m., and Friday, Aug. 16 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

October 6-11 in Reno "Advanced Management of Slot Operations" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, Oct. 6 from 5:30-7:30 p.m., Monday-Thursday, Oct. 7-10 from 8:30 a.m.-4:30 p.m., and Friday, Oct. 11 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks

and field trips.

November 3-8 in Reno "Management of Table Game Operations" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, Nov. 3 from 5:30-7:30 p.m., Monday-Thursday, Nov. 4-7 from 8:30 a.m.-4:30 p.m., and Friday, Nov. 8 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

December 8-13 in Reno "Surveillance Operations and Management" - A six-day gaming management program offered by the University of Nevada, Reno College of Extended Studies. Held Sunday, Dec. 8 from 5:30-7:30 p.m., Monday-Thursday, Dec. 9-12 from 8:30 a.m.-4:30 p.m., and Friday, Dec. 13 from 8:30 a.m.-noon at the university's Continuing Education Building, 1041 N. Virginia St. Course fee: \$2,500, includes instruction, course materials, lodging (five nights), meals, reception, refreshment breaks and field trips.

Registration and information: (775) 784-4062 or 1-800-233-8928.

For more about UNR's College of Extended Studies gaming management courses:
<http://www.dce.unr.edu/gaming>

Are you a slot tech with something to share? Join the best technical writers in the gaming industry at Slot Tech Magazine. See the website at slot-techs.com for writer's guidelines.



Test Fixture Project

By Herschel Peeler

throwing away the printers, we are turning them into test fixtures.

The printer control boards are easily adapted to a vari-

ety of applications. If we look at the design of the board from a technician's point of view, we see a board with potentials. It has an eight bit output port with ULN2064

Don't throw away those old printer boards!

At our casino, jurisdiction requirements prohibit us from having an MPU board from a game away from the all-seeing eyes of Compliance. A good and prudent policy, but it sure makes testing a pain. In order to test a board we have to design a test fixture that brings a peripheral board up under power in a simulated operation. In many cases, all that is needed to test a board is simple inputs (switches or logic drivers) and outputs (LEDs). Coin-In optics, Hoppers, Hopper Control Boards, and such are easily tested in this fashion. Other boards, such as seven-segment display boards, for instance, require a complex signal coming from a microprocessor. Smart testers can be created from scratch, or, if you don't like re-inventing the wheel, there is an alternative.

We have recently removed all our Sharp Image games from our casino. This left us with boxes of Telpar printers those games used. Instead of

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drivers (the dot pattern drivers). An H-Bridge driver with an L293 driver (the Knife driver), and an open collector (2N2222 – type transistor) output. There are three basic inputs coming from the printer board (two from the knife, one from the printer port).

The MPU is a standard 8031 design (very popular and easy to get information on). The MPU circuit itself has an eight-section DIP switch, a four-section DIP switch, and four scattered inputs, as Paper Out, Line feed, and such inputs.

Memory is straight forward with suitable EPROM and RAM for most small to medium size applications.

The ULN2064 and L293 are capable of driving up to an Amp, each, giving more drive power than is needed for most test applications. As an option, the high current drivers may be bypassed giving TTL compatible Inputs and Outputs to drive peripheral boards used in gaming machines.

There is also an RS-232 port built into the board that may be used to communicate with an external computer, or to

drive peripheral for the gaming industry that uses serial communication. This port is easily adapted back to a TTL serial port (as is used on seven-segment displays in gaming machines), or any other serial communication standard (Player tracking, and such).

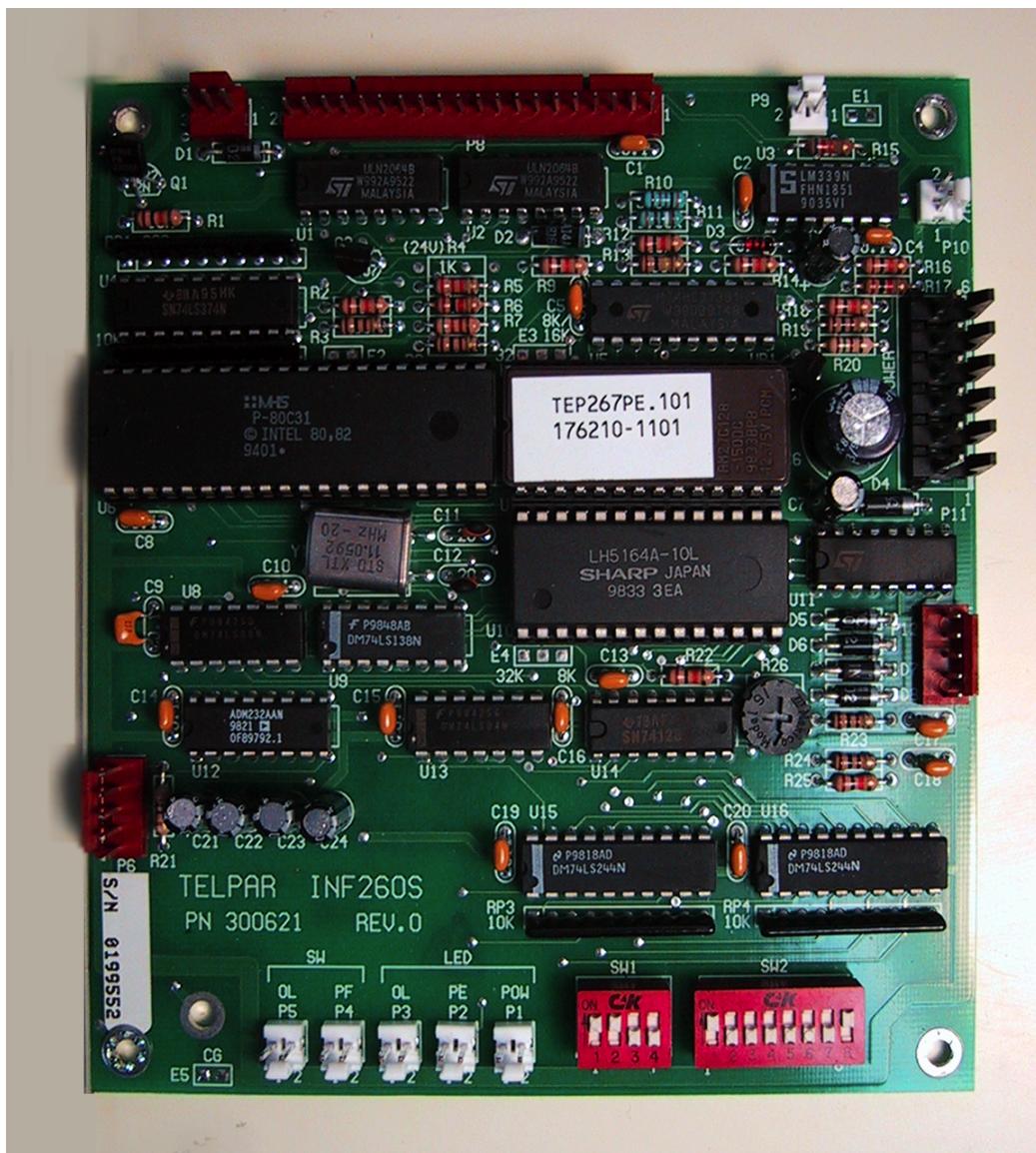
All-in-all boards such as this have grand possibilities as smart test fixtures where more is required than simple switch inputs and LED outputs.

If you have an interest in this, you may contact the author

at Eagle Mountain Casino, Porterville, CA, (559) 788-6220, ext. 1094. Ask for Herschel, bench tech.

Plans for the design are available in printed form or on floppy disk in OrCAD. OrCAD Lite has a free version that may be attained by mail from the company in Orem, Utah. Search on the keyword ORCAD on the Internet.

Editor's Note: Plans and schematic diagrams are available for download from the slot-techs.com website. Just follow the links. - rf



CashCode Sizzles at ICE

CashCode Co. Inc, has reported “overwhelming success” at the ICE Show in London, England, this January 2002. A larger tradeshow booth to accommodate heavier traffic, coupled with a tremendous customer response were cited by the company as the reasons for CashCode’s success at the show.

“We were humbled by the interest our MFL and FL products generated at the ICE show this year,...” said Val Levitan, CashCode’s Senior VP of Sales and Marketing, “...Our new, expanded product line demonstrated an unprecedented commitment to customer satisfaction that the

market responded to. This is because at CashCode we don’t make bill acceptors, we make high security banknote validators. In a cash-based business like ours, to accept counterfeit bills is not an option.”

This year marked the third time CashCode has exhibited at ICE, one of the biggest and most successful international gaming shows in Europe. The MFL (Multi-width Front-Load) Bill Validator unit was on display at ICE. This unit features multi-width note or coupon acceptance, as well as barcode and smart card technology. CashCode is currently the only manufacturer to offer self-centering mechanisms on these units, which properly guide banknotes with less chance of jamming.

CashCode manufactures banknote validators for the amusement, banking, bottling, gaming, kiosk, lottery, retail, petroleum, transportation and vending industries. Founded in 1991, CashCode is now recognized worldwide as a leading inno-



CashCode showed their unique MFL and FL products at ICE. Their units could be seen in action at Novomatic, Franco and Unidesa.

vator in bill validation technology. CashCode is also a leader in custom-applications manufactured in association with a number of industry Original Equipment Manufacturers (OEMs). CashCode offers its products and technology to customers in seventeen countries throughout North America, South America, Europe and Asia for a variety of cash-handling applications.

For further information, please contact:

Jenna Snyder Medvedev
CashCode Co. Inc.
905-303-8874, ext 2304
jennasnyder@cashcode.com



Slot Tech Magazine publisher Randy Fromm with Val Levitan, CashCode’s Senior VP of Sales and Marketing

"ICE 2002 was a great success for our entire group. In fact I would say that it's the best show we've ever had." - SABINA STOPPEL - EXHIBITION MANAGER, AUSTRIAN GAMING INDUSTRIES

ICE

Was really cool

Sorry for the corny title but it really was way cool!



Editor's Note: The International Casino Exhibition, ICE, 2002 was an absolutely wonderful event. It was held at Earl's Court (above) in London, January 22nd - 24th, 2002. I saw quite a few familiar faces there.

You (yes, YOU) can be a part of this as well. Every gaming professional is invited, even us technical types. You just have to set it as your goal to come here. Reasonably priced lodgings can be found nearby, the London Underground is easy to use and cheap, everyone speaks English and entrance to the show is free!

This page: Austria's gaming giant Novomatic showed a classy new, slimline slot machine that uses two LCD panels to cut the depth of the machine. They also showed a beautiful multi-station video roulette that uses a 42" plasma display. Why did the Moorhuhn cross the road? Hilarious!





“ICE was a really good show this year I congratulate the organisers for providing exactly what the industry needed after so many months of uncertainty; a truly great show.” said Ángel Gallego, General Manager of Unidesa Gaming (r) seen here beneath El Ratón Gigante with Communication Director David Orrick



Bally showed this prototype 3-coin progressive with the Playboy theme. There was a pesky Playboy Bunny hanging around the machine all day. I had to wait until she went off-duty to catch this shot of the machine.



Winner of the Best Stand award, the TCS stand was always busy. At a critical time in history for UK gaming, a main objective of the show for TCS was to ensure that UK operators had the chance not only to see the new proposed games in operation but to talk to other operators and the TCS team from overseas who had a working knowledge of the games.

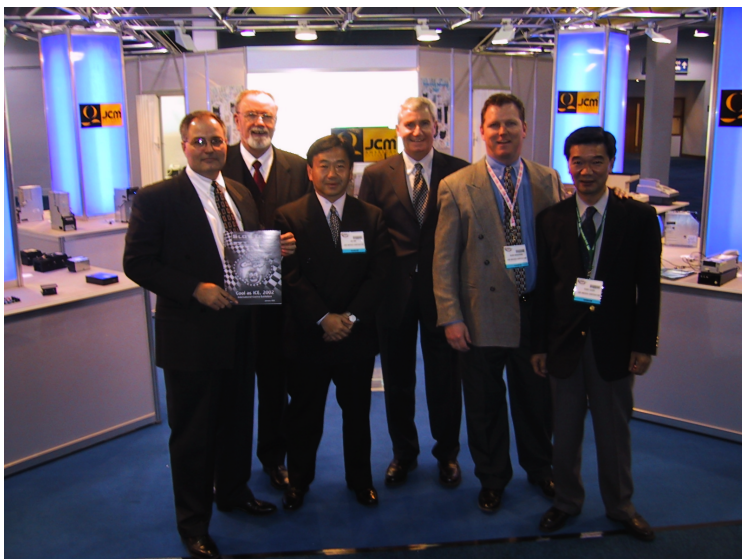
“An all round record-breaking show.” - KATE MCLENNAN MARKETING DIRECTOR, TCS GROUP



Component and replacement parts specialist Frank Happ (Happ Controls) paused on setup day for a chat with monitor manufacturer Tatung's Edward L.F. Chen. Tatung's stand at ICE was next to Slot Tech Magazine and, hey, isn't that a copy of STM they're each holding?



Coin Mechanisms' VP of Sales and Marketing Richard Currie (l) with the President and CEO of the company, Stanley Pierz.



Above - JCM displayed their bill validators and other products. (l-r) Tom Nugent - Director of Sales & Marketing - JCM American, Bepi Mottes - President JCM Germany, Aki Isoi - President JCM American, Keko Mottes - Director of International Sales - JCM American, Mark Henderson - Director of Sales - Western Region - JCM American, Terry Izawa - Director of Engineering - Osaka

Jon Temple (l) UK Sales Manager and International Applications Engineering Manager Ken Miller showed a variety of touchscreen solutions for both monitors and LCD panels at 3M Touch Systems (AKA MicroTouch)



Tekbilt Gaming's Buzz Bruner poses proudly next to his novel casino chip dispensing machine. Tekbilt also showed a new slot machine that will be featured in a future edition of Slot Tech Magazine.



Aristocrat showed their Cash Express Progressive. In addition to both video and stepper slots, the company offers casino management systems, multi-site progressive (MSP) systems, progressive jackpot meters and customized overhead sign packages.



Enhanced Slot Series

IGT entitled their stand Gamequest 2002. In addition to the release of 30 new titles and a new, curved button panel and slick looking plastic bezel (see My Rich Uncle, above) IGT showed their "Enhanced Slot" series which, contrary to what the name suggests, is actually a stripped-down, do-it-yourself slot machine cabinet based on S-plus that third-party vendors can build to suit their own requirements.

Spoo?

By Ken Locke



What is Spoo? Is it something spawned from a Springer Spaniel? Is it spicy spinach? Do you serve it on a Spork? Do you really need a lot of alliteration from an ambitious author?

This month we delve into the intricacies of firmware nomenclature. Specifically we'll look at IGT stuff, 'cause that's what I know. How do you tell one chip from another? What goes with what and so on.

In the 8032 microprocessor family we need to be familiar with two primary IC's; SP Chips and SS chips.

SP stands for Stepper Program. In the earliest days of IGT reel slots the chips were labeled with "SP" then with the assigned four-digit sequential release number. For example: SP0015. Some techs mistook the zeros to be O's and the Spoo chip was born. Nowadays SP numbers are in the 1000 range, i.e., SP1048. But they are forever spoos in the mind of the old vet.

Contained in a typical program prom are sounds, lights, hopper programming along with special game features such as nudge and haywire. Diagnostic functions, accounting and optioning are also inside.

SS stands for Stepper Slot. Suffice it to say, paytable information is contained in an SS chip. Using the SS number we can make reference to a specific PAR sheet. Each SS has a dedicated paytable and a payback percentage that cannot be varied.

Player's Edge games have a little different scheme, but there are some definite connections.

The **XP** Chip or XP Program Chip also contains the same information a typical SP would have, but it would have those options, features and diagnostics specific to a PE Plus video product.

X Data will in turn contain the paytable information for a given game set.

What PE Pluses have that SP Pluses don't are Character Generator chips known as CG's. U77 through U80. They will be labeled **MRO** (red), **MGO** (green) **MB0** (blue) **MX0** (text) respectively. Proper installation of these buggers is key here. Scrambled colors and text on a given video slot may not mean monitor trouble. It could mean our chips are in

the wrong sockets or have become corrupt due to mishandling.

If any of you out there are pensively awaiting for next release of S-Plus or PE-Plus firmware you need to let it go. IGT has fully developed 8032-based games for the sake of the i960 platforms.

Speaking of which, let's get right to it.

Within this group we have the Vision/S2000, Game King, iGame and iGame Plus electronic gaming machines. All of these are powered by the 80960 microprocessor created by Intel. This chip is capable of about 6 million instructions per second and can operate on 20 Mhz, but is set to 16Mhz on most IGT games.

Why did IGT select this particular microprocessor? According to Intel, its embedded 32-bit architecture allows it to be used in practically any high performance electronic device, really cool stuff like robotics, process control avionics and instrumentation and now gaming machines.

Don't think slots are that sophisticated? Just look at all the gadgets we stick on them.

Firmware, by the same token, has accelerated as well. Let's start with SG's

SG: Stepper Game. Today, game instructions need more

room to grow and as such SGs come in 16-bit pairs denoted Game 1 and Game 2, not to be confused with The Cat in the Hat's Thing 1 and Thing 2. Use the assigned number to look up the Program Summary Report (PSR).

Like their Grandpa Spoo, they also contain game instruction sets that hold optioning, diagnostics and specialized game features.

SB: Stepper Base. It's easy to spot as it is the only forty pin integrated circuit on the board. Continuing on the same traditional logic (yes, we use it occasionally at IGT), base proms contain payable information. But there is a little twist on this one.

With old SS chips only one payable was available inside. If a property wanted to change its percentages it had to buy a new chip. SB's on the other hand have multiple PAR sheets inside called, for reasons foreign to me, **LS**. To adjust between selectable paytables requires a key chip. Its assigned number can be used to find its particular PAR sheet

Now I know what you're thinking. You can find some 960 reel games with the old SS chip still in them. Here's why. Since many of the old tried and true game themes continued into the future, we wanted to keep those paytables. Rather than re-embed them onto the new base proms we simply told the SB to defer to payable on the old SS.

In a nutshell, the SG tells it how to play, the SB tells it how to pay. The game prom tells the reels to spin and

some symbols to land on the payline. The SG says 'hey, base prom, is that a winning condition?' If there is an SS chip on board the SB says 'hell, I don't know. I'll go ask the SS chip'. A dead giveaway is the SB is labeled SB1000 or SB00001.

One more unique chip appears on the Vision/S2000 game, the version chip (VSN). Very simply the version chip either allows or disallows certain functions of the game firmware dependent on jurisdictional requirements. For example in New Jersey a Jackpot to Credit option is not permitted. Rather than reinvent firmware for one region we customize it through an additional chunk of firmware.

On to Game Kings and iGames. Just like their spinning cousins they also utilize a Game Prom pair. They are denoted with a **GXXXXXXX** and **IXXXXXX** in iGames.

They also contain a Base Prom containing paytables but consider this: A typical Game King firmware set can hold a couple of dozen separate games each with varying paytables within. A PAR sheet for just one chip set can be a stack of paper an inch thick. Surf through your individual Version Accounting option on your operator's menu for the right payable. They are usually denoted by **MXXXXX**. The "M" indicating it is a multi-game.

A pair of pixel (**PXL**) chips and a pair of character generator (**CG**) chips gives us our imaging data. On the more sophisticated game themes single in-line memory modules (SIMMs) can also be

employed. Sound (**SND**) proms can be found to contain custom audio files on the multi-media daughter board.

Then you've got your **Key/Set Chips**. The terms can generally be used interchangeably but as rule, Set chips refer to those controlled Proms that enable high-security functions on the 8032-based machines, while Key chips work with i960 units. Finally, we come to Clear Chips (**IVC**). These ICs are used to clear all meter data and restore default factory settings to the machine. Clear chipping could be necessary when converting game themes.

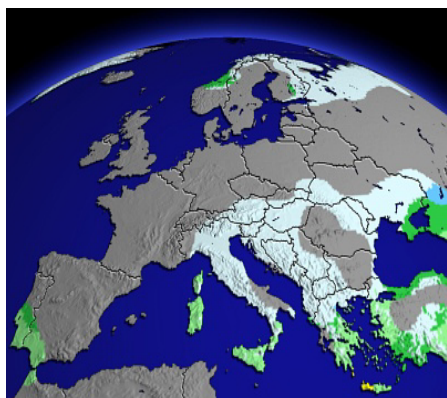
One question that I am asked time and again is "How do I know what Game chips go with which Paytable chips?" It's not an unreasonable question. But it is a little more complex than you might think. What makes them compatible goes well outside the scope of this spunky little publication. Mixing and matching may not prove practical or even legal. The best way to know, call your customer service representative. Tell them what theme you want and your desired hold percentage; they'll do the rest.

And that boys and girls is the story of Spoo and stuff like Spoo. Most times firmware connotations make sense, sometimes not so much. But hopefully you've learned how to properly identify IGT firmware. And, I learned that Spoo is really fun to say. Spoo, spoo, spoo, spoo, spoo!

- Ken Locke
ken.locke@igt.com

International View

By Martin Dempsey



C.I.S. Supplies Novomatic In Russia & CIS

C.I.S. Supplies Ltd is the exclusive distributor of Novomatic (Austrian Gaming Industry) gaming machines in Russia and the Commonwealth of Independent States countries. C.I.S. Supplies Ltd provides its customers with comprehensive technical support and guarantee services assuring continuous operations. C.I.S. Supplies Ltd also distributes DigiDeal Corporation products. DigiDeal is the inventor of the dynamic DCSTM Digital Card System high quality products. DCSTM products are traditional table games combined with the best aspects of slot machines. Its electronic Black Jack game (called Digital 21) has the look and feel of a Black Jack. It's Bonanza Black Jack has an side bet with a \$25,000 jackpot amongst other unique possibilities. Information about C.I.S. Supplies Ltd and its various products can be found on the Internet at: <http://www.cissupplies.com>

or <http://www.novomatic.com>
or <http://www.digideal.com>
For further information
contact their Sales Department in St. Petersburg,
Russia.
Tel.: (8) 812-303 83 72/74/75
E-mail:
mikhstolpner@yahoo.com

Barcrest & Gauselmann Group Complete Deal For German Payout Market



Barcrest has announced the conclusion of negotiations and exchange of exclusive contracts with Gauselmann Group that will now see Barcrest branded games designed at the company's Ashton-under-Lyne offices entering into the important German payout market. Robert Lamb, Managing Director of IGT-UK Limited trading as Barcrest, Vivid Gaming and Red Gaming, commented; "We are pleased to have finalised this long-term, stra-

tegic business arrangement with Gauselmann Group in respect of the German payout market and are looking forward to a most successful and mutually beneficial relationship." Paul Gauselmann, Chairman of Gauselmann Group, added; "The combination of Barcrest's strength in games design and strong brand awareness, together with the proven technological excellence of adp Gauselmann, is a solid base from which to market successful and innovative products into the German Payout Market in association with Slots Trading SA and Max Walberer GmbH." Paul Terroni, the IGT-UK Director responsible for this new initiative, explained the sales and distribution arrangements that have also been put in place. He said; "We have enjoyed an excellent relationship with Walberer Automaten for a number of years, especially in respect of the German fun market. It is equally pleasing, therefore, to confirm an agreement for Walberer Automaten to handle sales and distribution of Barcrest created products produced by adp Gauselmann GmbH in their own technology for the German payout market. As a consequence, we can certainly promise a host of exciting new games that will deliver great performance and player appeal." The first AWP machines under this co-operation for the German market are to be delivered in the course of the year 2002.

iGGBA Gains Exclusive Insight

Clive Hawkswood, a senior UK government official at the Department of Culture Media and Sport, was the guest speaker at a meeting of the Interactive Gambling Gaming and Betting Association (iGGBA) staged at London's International Casino Exhibition. iGGBA members were treated to what was described by attendees as "an exclusive insight" to the government's current thinking relating to i-gaming and the recommendations set out by the Budd Report. Nick Harding, chairman of iGGBA explained: "This was an extremely productive meeting for everyone involved in the association. Clive Hawkswood made it clear that, from the Department's point of view, iGGBA will play an important role in presenting ideas on how the i-gaming sector can develop in this country. It was an interesting and stimulating debate which covered issues including the type and timing of legislation and ways in which the industry can interact with the DCMS." He added: "It was also agreed at the meeting that iGGBA will frame a paper to outline an industry approach to future regulatory compliance." Since its formation in September 2001, iGGBA, the UK industry's newest trade association, has attracted 25 members including Harrods, Gala, Sportech, Ritz, Corals and the latest recruit, MGM Mirage. Membership is open to all UK-registered organisations with on-line interests.

Hydra Create Launches EuroCab

After a successful first year, Hydra Create exhibited their first Hydra branded product at this year's ATEI. Alfio

Monterosso, Hydra's Sales Manager said "The Eurocab, is a versatile "off the shelf" AWP cabinet, available to all and in any quantity. The aim of this project is to design a quality cabinet that can be used in most international markets. It is extremely functional and aesthetically pleasing, all at a low price. We are pleased to say that a number of companies have already expressed their interest in using this cabinet, particularly for the Spanish market. It has front opening removable doors, a secure front removable hopper assembly which can accommodate up to 3 hoppers. It can be fitted with any coin validator and has room for up to 10 reels. It can also be fitted with whatever technology the customer wishes to use. Most importantly, it has been designed so that the conversion time from an empty shell to a complete AWP is minimal, reducing manufacturing costs significantly. In fact it is so easy, that I believe game developers would be tempted to assemble their own machines. Finally, I would like to take this opportunity to thank Starpoint for kindly allowing us to exhibit the Eurocab on their stand. For further information on the Eurocab please contact Alfio on +44 (0)1902 571986 or alfio@hydra-create.com

Franco Gaming Launch Phoenix

FRANCO GAMING LTD having launched the first of the newly manufactured PHOENIX range of slot machines at ICE 2002 is now busy organising production lines for the orders received at and since the exhibition. Derek Lynch the MD of Franco Gaming is absolutely delighted at the initial response to his first



Franco Gaming was a hotbed of activity at ICE

independent foray into machine manufacturing and cannot wait to get supplies to those customers who believe in his ability to design suitable games for specific markets. The AMEX show in March will see Derek displaying his full range along with IGT & Bally remanufactured slots for the Irish market. Furthermore the OLAS Machine Management Control System from Future Gaming, for which Franco Gaming is a distributor, will be fully operational at AMEX following some very positive results at ICE.

Martin Dempsey
MD Associates
Enterprise Centre
Melitta Road
Kildare Ireland

Email
mdassociates@eircom.net
Phone + 353 (0)45 521190
Fax + 353 (0)45 521198
Mobile + 353 (0)87 2209732

Introduction to The Oscilloscope

Before I get started telling you about the really swell things you can do with an oscilloscope, I want to take a minute or two to try and convince you *not* to buy an oscilloscope. You heard me correctly!

If you already own an oscilloscope, great! I'm gonna show you how it works. I'm gonna show you what all the knobs and switches do.

But if you do not own an oscilloscope right now, you should think again before you run out and spend \$1000.00 or more on an oscilloscope.

Don't buy a scope:

if you expect the purchase of an oscilloscope to make it easier for you to fix the vast majority of problems faced by slot techs. It won't, simply because the vast majority of slot machine failures do not require an oscilloscope in order to make fast, efficient repairs.

if you have reasonably priced, reasonably fast board repair service available to you from an outside source.

because you have just hired a "hot-shot" technician that says he absolutely must have an oscilloscope before he can fix anything.



if you are only fixing a very few power supplies and monitors.

unless you are currently very serious about electronics or plan on becoming very serious about electronics. VERY SERIOUS! I'm not kidding here. Knowing how to operate the oscilloscope doesn't actually help you fix anything at all unless you know how the circuits themselves work and how to interpret the oscilloscope display that you've just worked so hard to get up on the screen!

Do buy a scope:

if you plan on repairing microprocessor or other digital electronics systems. This includes everything from old, S-Plus boards (a very good place to start learning about digital electronics, by the way. IGT's S-Plus is a wonder of simplicity and yet, at the same time, provides

the novice technician with samples of many different types of I/O and other, microprocessor-related circuits. Look for an S-plus educational series to begin soon in Slot Tech Magazine) to flat-panel display drivers and network interface.

if you are working on a large number other, sort of off-the-wall electronics systems. For example, slot departments at some casinos are asked to fix everything from office equipment to surveillance systems and might use an oscilloscope to track down a variety of unusual problems regarding signal strength or noise; problems that would be difficult to locate using just a digital multimeter.

if you are the monitor specialist for a large operator or casino and you spend a great deal of time working on the "tough dog" monitors that other people have tried (and failed) to repair. In situ-

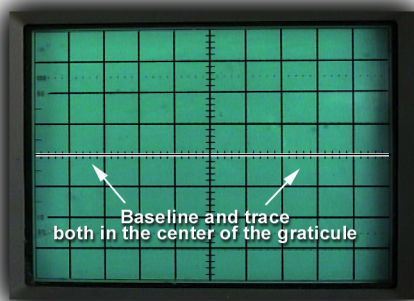


Fig.1 - Start with the baseline in the exact center of the graticule.

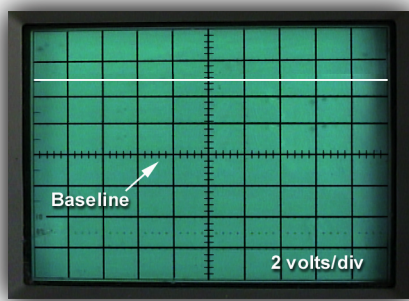


Fig. 2 - Applying a positive voltage to the input of the scope will make the trace will move up.

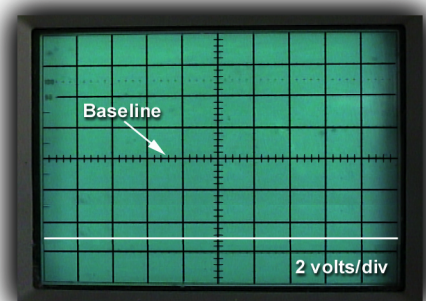


Fig. 3 - Applying a negative voltage to the input of the scope causes the trace to move down.

ations like this, just about anything is possible. The wrong parts might be installed or a replacement part may be installed improperly. Component testing alone may not located a defective part here, so active circuit tracing with an oscilloscope may be the only way to troubleshoot the circuit.

What is an oscilloscope?

An oscilloscope is a graph drawing machine. It displays a simple graph that shows “voltage” in the vertical direction and “time” in the horizontal direction. The oscilloscope uses two different types of circuits to create the graph on the face of the display.

The Vertical Circuit

The higher the voltage, the greater the vertical movement of the display. The grid on the face of the oscilloscope (called the “graticule”) helps you measure the amount of vertical

movement of the display (see figure 1.)

A vertical position control moves the “trace” up or down on the screen (see figure 4.) With the input switch set to “GND” (this grounds the input, making the input voltage to the oscilloscope 0 volts) adjust the position so the trace is exactly in line with

one of the horizontal lines of the graticule. This “baseline” position will vary, depending on the signal you’re looking at. For the sake of discussion, let’s start with the baseline in the exact center of the graticule (see figure 1.)

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

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

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

Whoopee . . .

That’s pretty stupid, isn’t it? Surely the scope can do something else. Well, you can also measure voltage by using the graticule. The space between two adjacent lines is called a “divi-



Fig. 4 - This is the vertical section of the Tektronix 2235

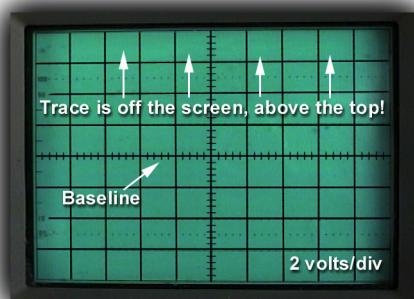


Fig. 5 - If we move to the +12 volt DC output of the power supply, the trace disappears! Where did it go?

sion.” On this oscilloscope, there are eight vertical divisions. To make more precise measurements, each major division is divided into five subdivisions.

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

For example, let’s “scope” the three outputs of a typical power supply. The oscilloscope ground is connected to the DC ground of the power

supply and the oscilloscope is set to 2 volts/div. The baseline is still set in the center of the graticule.

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

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

If we move to the +12 volt DC output of the power supply (see figure 5) the trace disappears! Where did it go? Scoping the +12 volt output with the baseline set to the middle of the graticule and the oscilloscope set at 2 volts/division puts the trace off the top of the display; two divisions higher than top edge of the graticule.

Many oscilloscopes have a “beam finder” button. Pressing the beam finder will show you where the trace is regardless of where you have set the volts/divi-

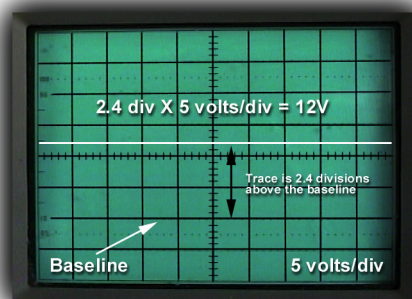


Fig. 6 - If we want to 'scope the +12 volt output of a power supply, we'll probably set the baseline down on the bottom somewhere.

sion control. In this case, pressing the beam finder reveals the trace at the top of the display.

Let’s set the vertical input to 5 volts/div. Anytime you reset the volts/division, you should check your baseline! Set the input to “GND” (see figure 4) and use the vertical position to pick a convenient line on the graticule. It doesn’t have to be the center line. In fact, it often is not. If, for example, we want to scope the +12 volt output of the power supply, we’ll probably set the baseline down on the bottom somewhere (see figure 6.)

Since we’re not going to be



Fig. 7 - The 10X probe. For every 10 volts at the tip of the probe, 1 volt is applied to the input of the oscilloscope

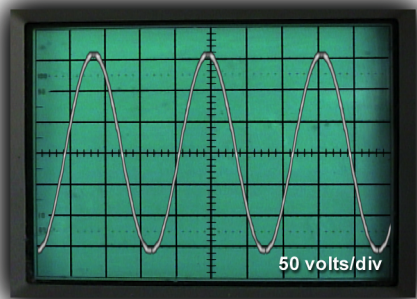


Fig. 8 - This is what household AC power looks like on an oscilloscope. It's called a "sine wave."

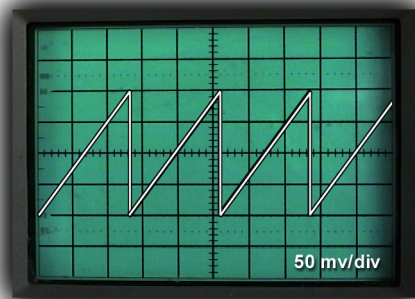


Fig. 9 - The aptly named "sawtooth wave."

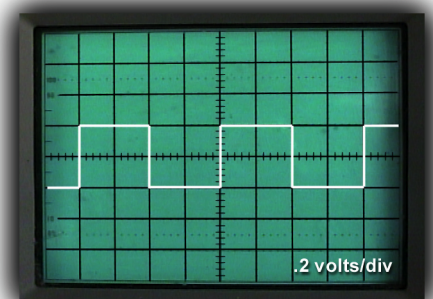


Fig. 10 - Obviously, a "square wave."

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

The maximum is 5 volts/div. That sucks because even if you use all eight divisions, you're looking at a maximum of only 40 volts. There are plenty of circuits that use more than 40 volts.

This problem is solved by using a 10X (times 10) probe (see figure 7.) For every 10 volts at the tip of the probe, 1 volt is coupled to the input of the oscilloscope. In general, we do all our work with the 10X probe. With the 10X probe, 5 volts/div becomes 50 volts/div and the oscilloscope can display a signal of up to 400 volts on the screen. Not only does this allow us to measure higher voltages, but it helps to avoid accidentally overloading the oscilloscope with too much input voltage. Circuit loading is also minimized because of the extremely high impedance (internal resistance) of the 10X probe.

Let's look at some other signals. Figure 8 shows what household AC power looks like on an oscilloscope. It's called a "sine wave." Other waveforms you may observe on an oscilloscope include a "sawtooth wave" (figure 9) and a "square wave" (figure 10.)

Sometimes, a fluctuating voltage will "ride" on the top of a steady, DC voltage (see figure 11.) This signal may be only a fraction of a volt but it's riding on top of a much higher voltage. In a power supply, this fluctuating voltage is an undesirable condition called "ripple." If we want to take a closer look at the ripple, we'll need to boost the sensitivity of the vertical input to see it. Unfortunately, lowering the volts/div enough to see the ripple causes the displayed line to disappear off the top of the screen due to the DC component of the signal.

How can we see the ripple? Easy! Flipping the "input coupling" switch to "AC" does the trick (see figure 4.) Flipping the input coupling

switch to the AC setting places a capacitor in series with the input to the oscilloscope. The input coupling capacitor blocks the DC component of the signal, allowing only the AC ripple through to the vertical input of the scope. When you flip the input coupling to AC, (see figure 12.) the trace drops back down to the baseline. When you have the input set to AC, you will usually have the baseline set to the center of the graticule. With the DC component of the signal removed, we can crank up the sensitivity of the vertical input in order to display the ripple.

Vertical Mode Controls

There are two vertical inputs on this oscilloscope (see figure 4.) This is common. Most oscilloscopes are "dual channel" scopes. In this oscilloscope they're labeled channel 1 and channel 2. The vertical mode switch lets you select channel 1, channel 2 or both channels at the same time.

The two channels allow the

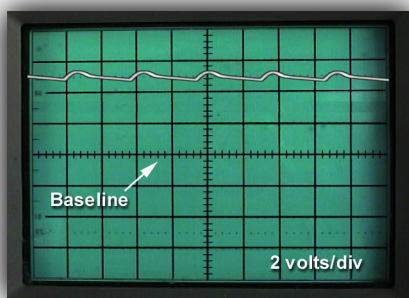


Fig. 11 - Sometimes, a fluctuating voltage will “ride” on the top of a steady, DC voltage

oscilloscope to display two different signals. For instance, while troubleshooting a digital circuit, you might need to examine an “enable” signal and a “data” line at the same time. Channel 1 can be connected to the look at the enable input of the chip while channel 2 examines the data.

The oscilloscope cannot actually display both signals at the same time. There is only one “beam” in the CRT so it can only draw one trace at a time. The oscilloscope displays the 2 separate channels by “time sharing” the beam.

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

The other method of displaying both vertical channels is

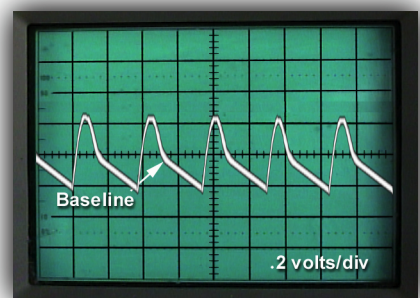
called “chopped.” The oscilloscope will first display a portion of the channel 1 waveform, followed by an equal portion of the channel 2 waveform. The two input signals are chopped up into small bits. The chop rate in the Tektronix 2235 oscilloscope is around 500 kHz. This setting is best for displaying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

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

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

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

For example, there are two types of ripple in a switching regulator power supply. One is high frequency ripple at about 40 - 50 kHz. This comes from the switching action of the transistors. Another is low frequency ripple at 60 Hz that comes from the 120 volt AC line.



When you flip the input coupling to AC, the trace drops back down to the baseline. With the DC component of the signal removed, we can increase the sensitivity to .2 volts/div display the ripple.

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

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

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

This oscilloscope has another control called "bandwidth limit." The real world of electronics is not nearly as clean as the theoretical world. In the real world, all kinds of high-frequency electrical "noise" can creep into your displayed waveform. Some of this noise is generated by the circuits themselves. Some comes from various outside sources. When engaged, the bandwidth limiter cuts the "bandwidth" or frequency range from 100 Mhz to 20 Mhz. This cleans up the display, giving you a sharper trace. Naturally, you won't use this setting if you're trying to look at high-frequency signals or signals with fast rise or fall times. A 100 MHz oscilloscope is fine for work on gaming equipment. Higher bandwidth is desirable but not necessary.

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

Next Month: Part 2 - Horizontal Sweep

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Sorry, I couldn't resist - rf

Switching Regulator Power Supplies

Part 2 - Troubleshooting

There is only a small handful of components that commonly fail in switching regulator power supplies. Bad power supplies can be segregated into two groups for easy troubleshooting. Power supplies that blow the fuse go into one group while the remainder (those failures that do not blow the fuse) go into the other.

Power Supply Failure - Fuse is Blown

One of the most common failures is the switching transistors themselves. The two transistors are mounted on a heatsink that helps them run cooler. Test them by using an ohmmeter or with a digital multimeter set to the diode test range. All testing is done with the power off. Check each switching transistor for a short circuit between emitter and collector. Replace any transistors you find to be bad.

Although some techs claim that you should replace them both even if just one is bad, this is not necessary. However, both transistors must be of the exact same type. Specifically, they must be closely matched in their "gain" or "beta". Mismatched transistors can cause problems. Unless you have an exact replacement, you should replace them as a pair.

By the way, these transistors will often seem to test shorted between base and emitter when tested "in-circuit." Don't bother testing the base-emitter junction of the transistors. When the switching transistors fail, they always short between emitter and collector and blow the fuse. If you're in doubt, pull the transistors out of circuit to test them. However, an in-circuit test from emitter to collector is all that is necessary. A short circuit means the transistor is likely bad. Anything else (a junction drop or open reading, for instance) means that the transistor is good.

There are only two other component groups that will blow the fuse in a switching regulator power supply. There is a pair of diodes that is directly associated with the pair of switching transistors. These are known as the "clamping diodes" and they're easy to find. They are always located just in front of or immediately behind the two switching transistors. They are small, 1 amp sized diodes. A typical part number for these diodes might be something like PXP1507 or FR1507. The clamping diodes serve to protect the transistors from high voltage spikes but sometimes the clamping diodes themselves fail. Bad clamping diodes will always short circuit and blow the fuse.

Note: When a clamping diode fails, it will make the associated switching transistor appear to have a collector-to-emitter short when tested in-circuit. If you find a bad transistor, be sure to double-check it after removing it from the board. Also, check the clamping diode again with the transistor removed. You may find that the clamping diode is also shorted or that the transistor itself is actually good and that the clamping diode is your only failure.

The only other failure that commonly will blow the fuse is the bridge rectifier. The bridge rectifier is connected through the fuse to the 120 volt AC power. You may find a one piece bridge rectifier or four individual diodes depending upon the manufacturer or model of the power supply. As with the clamping diodes, a bridge rectifier will always short circuit and blow the fuse when it fails.

The only other component failure that might blow the fuse is the AC input capacitor. This capacitor sometimes looks like a piece of Chiclets chewing gum and has a typical value of .047 to .1 microfarad. The capacitor is part of the AC line filter circuit. In this case, it's directly across the 120 volt AC input (between the "hot" and "neutral" connections) following the line

fuse. Naturally, if this capacitor short circuits it will blow the fuse. Nothing else in the power supply will be bad. Most of the time, you can just yank out the bad cap (wiggle it back and forth to break it out) and operate the power supply without it. However, if the monitor shows interference, you'll have to replace the capacitor to maintain the AC line filter circuit at optimum efficiency. Test the capacitor with your meter set to ohms. Like the semiconductors, this component short circuits when it's bad. Out of circuit, it will read open when good. The in-circuit reading will vary between power supplies.

When you have a power supply with a blown fuse, be certain that you check all four of these items (the switching transistors, the clamping diodes, the bridge rectifier and the AC input capacitor) before replacing the fuse and applying power to the unit. One, two, three or all four of these component groups can have problems so test everything first (with the power off) to avoid frustration.

Power Supply Failure - Fuse is Not Blown

Output diode failure is a common problem. There are generally a number of output diodes in a switching supply and failure of any one of them will cause the supply to shut down. Failure of these diodes will not blow the fuse. The power supply's over-current protection circuit (OCP) simply detects the short and

shuts down the power supply.

If the power supply fuse is not blown, start by testing the output rectifiers. There is generally a pair of output diodes for each power supply output. For example, one pair might be for the -5 volt output. These will be fairly small; approximately the same size as the ubiquitous 1N4004 with which we are all familiar. The part number is generally something like PXP1502 or FR1504. The +12 volt diodes are usually in the somewhat larger (3 amp) package. A typical part number here is PXP302 or FR3004. The +12 volt output diodes are also found as a diode package. Typically, it's a TO-220 package.

The two +5 volt output diodes are almost always housed together in a "dual-diode" package (usually a TO-218 package). It looks just like a transistor but it is not. It often has the diode symbols printed on it. The two cathode connections are tied together at the center lead of the device while the two anode connections are on either side of center. Like the switching transistors, this diode package is mounted on a heatsink. The +5 volt diode is also known as a "schottky", high-speed diode. A typical part number is CTB-34.

These diodes generally will not test properly in-circuit, even if they're good. For example, power supply outputs will often have a 50-100 ohm resistor across them as a load

resistor to ensure start-up under low-load or no-load conditions. This causes your in-circuit reading to indicate that the diodes are bad, even though they might be good.

Here's a real time-saver for testing the output diodes. When an output diode fails, it will become a dead short (zero ohms). If your meter indicates a complete short circuit, one or both of the diodes is bad. Any other low resistance reading (100 ohms, for instance) means the diode is good. Try checking the diodes in a good power supply to see how they test. When you find a power supply with bad output diodes, the difference in the readings will be obvious. By the way, when just one of a pair of output diodes is shorted, they will both appear to be shorted when tested in-circuit. Unsolder and lift one end of one of the diodes to identify the culprit. You have a 50/50 chance of getting the right one on the first try.

The +5 volt dual-diode package can be tested in much the same way as the +12 and -5 volt diodes. You will find that the in-circuit reading for the +5 volt diode is even lower than that of the +12 and -5 volt output diodes. Again, you should check the Schottky diode on a good power supply to see a normal reading. As before, a bad diode will be easy to identify as it will be completely shorted. There seem to be very few failures of the +5 volt output diodes.

All output diodes (and the clamping diodes as well) must

be replaced with special, high-speed diodes. These are sometimes referred to as "fast recovery" diodes. Conventional diodes will overheat and fail prematurely. The diodes in the bridge rectifier circuit can be replaced with conventional diodes.

Bad IC?

If the diodes are good but the supply is still inoperative, the integrated circuit may be bad. Test the IC by removing it from the printed circuit board and installing it in a power supply that you know to be good. An integrated circuit tester can be made in just a few minutes by removing the integrated circuit from a spare power supply and replacing it with a socket. Connect a 6 volt lamp between the +5 volt output and ground so you can tell if the test unit is working. Connect your spare power supply/IC tester to the 120 volt power. If the light comes on, the integrated circuit is good!

Just about all the supplies use the same IC; a type 494. Equivalent integrated circuits are: TL494CN, uA494, uPC494C, IR3MO2, KA7500 and MB3759. The over-the-counter replacement for these is a Phillips ECG 1729.

What Powers the Integrated Circuit?

When you have checked and/or replaced all of the components mentioned previously in this article and found nothing, you have to

ask yourself "Does the IC itself have power?" Naturally, there can be no drive output from the IC to the switching transistors if the chip itself has no power supply.

But where does the IC's power supply come from? Early versions of this style of power supply actually had a small, transformer-based power supply within the switching supply itself. This was a full-wave, center-tapped power supply that used a center-tapped step-down transformer, a pair of diodes and a filter capacitor to create an unregulated low voltage power supply of around +16 VDC. This power supply was used to power the integrated circuit and nothing else.

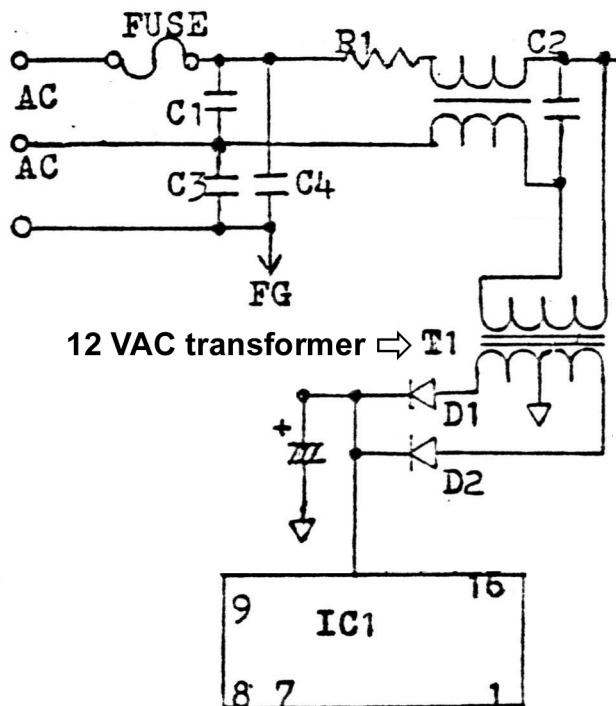
However, the little transformer, the two diodes and the electrolytic filter capacitor adds to the cost of manufacturing the power supply. The power supply could be made at a lower cost if this "supply within the supply" could be eliminated. After all, there are a couple of DC sources within the box already (the +165 VDC primary supply and the +12 VDC output). Can't we use

one of these to power the IC and eliminate the transformer?

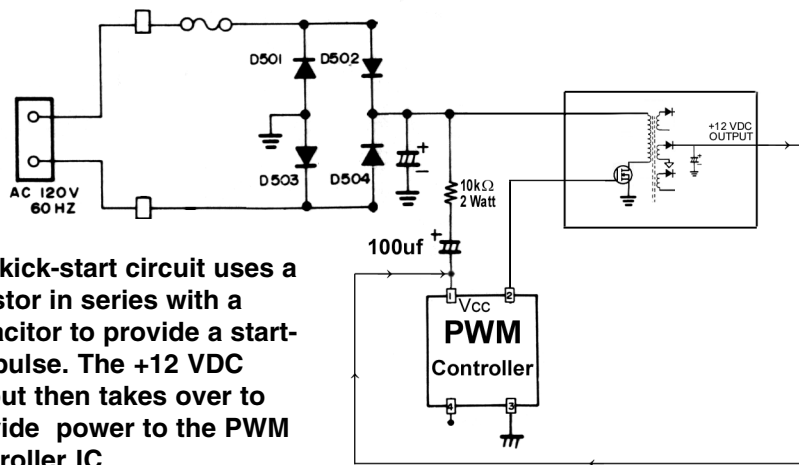
Okay . . . Here's the IMPORTANT part: The answer is that we use both!

Here's the deal. The integrated circuit works off any power supply from +12 VDC to +18 VDC or so. The supply voltage isn't critical nor does it have to be regulated. Since the power supply already has a +12 VDC output, we can use THAT to power the IC. The +12 VDC output of the switching supply is simply connected to the power supply input (also known as Vcc to the truly hip and well-informed technician) of the chip. Simple, huh?

But wait a second. How can



Early versions of the switching power supply used a transformer, a pair of diodes and a filter capacitor to create a low-voltage power supply to power the IC.



The kick-start circuit uses a resistor in series with a capacitor to provide a starting pulse. The +12 VDC output then takes over to provide power to the PWM controller IC.

we get a +12 VDC output from the power supply unless the IC is working? Moreover, how can we get the IC to work unless we already have a +12 VDC output?

Kick-start

The answer is that we can't. It's a paradox. We need to throw something else into the mix and that "something else" is where this introductory discussion is leading. It's called a "kick-start" circuit and it's one of those types of circuits that's almost guaranteed to fail after a few years (or more) of operation.

The kick-start circuit is about as simple as it gets. It's made of just two components: a resistor and a capacitor. Here's how it works:

Somehow, we have to get the integrated circuit up and running in order to create the +12 VDC output that the IC requires for Vcc. In reality, we need power for only a fraction of a second to make this happen. It's analogous to jump starting a car with a dead battery. You need the jump for just a few seconds.

Once the engine has started, the vehicle's own generator (or alternator) takes over to provide electrical power to the system.

The kick-start circuit is connected between the +165 VDC power supply and the Vcc input of the chip. No, we're not connecting +165 VDC to the Vcc. That would blow up the chip. The function of the resistor is to cut down the voltage to an acceptable level. The value of this resistor varies between designs but a typical value might be 10K ohms, 2 watts.

But we don't need (nor do we want) continuous current flow through the resistor. Continuous current flow would burn up the resistor. We just need a momentary pulse; just enough to get the power supply started. This is where the electrolytic capacitor comes in. Capacitors have an interesting electrical property in that when fully charged, they block DC.

When the power supply is off, all of the voltages are, of course, zero. All capacitors are fully discharged. When

the power supply is first energized, current will flow from the +165 VDC power supply, through the resistor and through the discharged electrolytic capacitor to the Vcc input of the integrated circuit. This gives the IC its kick-start, enabling the +12 VDC output.

Just a fraction of a second later, the electrolytic capacitor in the kick-start circuit has become fully charged. This blocks the flow of DC, essentially shutting down the kick-start. That's okay because the +12 VDC output of the power supply is now up and running and the integrated circuit can now use it as its Vcc source just as in the case of the automobile jump start. Pretty neat, huh?

Failures

Since there are only two components in the kick-start circuit, there are only two things that can fail (Duh!): The resistor can open circuit or the electrolytic capacitor can fail. Often, it's both. Here's what happens . . .

Electrolytic capacitors fail in a few different ways. One is that the electrolyte in the capacitor dries due to heat. As the electrolyte begins to dry, the capacitor loses its capacitance; it has less "microfarads." Eventually, the capacitor cannot pass a sufficiently large pulse through itself and the IC never gets its kick-start. This type of failure is often accelerated by excessive heat as the power supply itself can get pretty warm.

Add insult to injury by putting the power supply in a box and putting that box inside a nice warm cabinet. Further, you often will find a common design error here. Remember that the kick-start circuit is comprised of an electrolytic capacitor AND a fairly high wattage resistor that gives off heat. Since these two components are connected in series, they are often mounted right next to each other. **MISTAKE.** The heat from the resistor simply accelerates the capacitor failure.

Another type of electrolytic capacitor failure is that they become excessively "leaky." That is to say, instead of presenting a pure capacitance to the circuit, they act as if there is a resistor connected across the two terminals of the capacitor as well. This totally blows the DC blocking function of the capacitor, allowing a continuous current to flow through the capacitor and, of course, the series resistor as well. This causes the resistor to overheat and fail as an open circuit.

Of course, the resistor itself might simply have opened on its own but that's not nearly as likely. Resistors often fail as a result of some other component failing first and taking the resistor along with it.

The bottom line is that we're only talking about two components here. You can test the resistor with your meter. If it's good, replace the electrolytic capacitor. If the resistor is open (or has increased in value), replace both the capacitor and the resistor. **ALWAYS** replace the electrolytic capacitor, regardless. Don't bother testing it. It may test good with a capacitor meter but still be bad. Not all capacitor meters can test for leakage. In fact, few can.

A few years ago, I held a training session for the US Air Force Agency Services at Lackland AFB in San Antonio, Texas. We had a number of bad power supplies from Bally V7000 slot machines. Most of them had bad kick-start circuits (open resistors and bad capacitors). We're talking about less than

a dollar's worth of components here. Before the class, they had been paying \$156.00 each for replacement power supplies. Not anymore. We found the exact same kick-start failures in the power supply for their progressive jackpot system as well. That was a \$250.00 power supply. **THIS** is why I love being a technician!

Capacitor Failures

It is extremely common to find output filter capacitors that are swollen or leaking. Any capacitor that appears to be bad should be replaced. To prevent a recurrence of this all-to-common failure, output filter capacitors should be replaced with special "low ESR" (Equivalent Series Resistance) capacitors. These capacitors are specifically designed to handle the rigors of filtering in a switching supply. It is well worth the extra cost to use low ESR capacitors as replacement components because they can double the life expectancy of the power supply.

Power Supply Failures	
Blows Fuse	Does Not Blow Fuse
Switching Transistor(s) Clamping Diode(s) Bridge Rectifier AC Input Capacitor	Shorted Output Diode (any output) Bad PWM Controller IC Bad "Kick-Start" Circuit
Note: Regardless of failure mode, always examine/test/replace the output filter capacitors. Capacitor failure is common in switching power supplies.	

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