SLOT TECH MAGAZINE

Slot Machine Technology for the North American Gaming Industry

September 2008

Slot Tech Magazine

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September 2008

Randy Fromm

Dear Readers,

This month, Slot Tech Magazine is featuring a color centerfold. Go ahead. Check it out. It's really a thing of beauty. I'll wait.

Does it look a little familiar? As you can see, it's the schematic diagram for the MK5PFC power supply from last month. This time, it's big enough to read without a magnifying glass. There is also another big difference. I have added colored lines for important busses such as the high voltage DC primary bus, the +24 VDC output bus, ground busses and so on. The addition of the colored lines make the schematic much easier to understand and with a unit of such complexity, knowledge is the key to successful troubleshooting.

In part two, we will examine the PWM controller and the secondary (24 volt) output. We will also take a look at voltage regulation and frequency compensation. All of that stuff is pretty basic and we've really covered it a few times before. That's generally not the challenging part of this unit.

What is interesting is the way the power supply protects itself (and the slot machine system in general) when things aren't exactly going as planned. The unit is rife with protection systems that look for things like over-voltage conditions, under-voltage conditions and even the internal temperature of the power supply! Along the way we'll learn about the voltage comparator and see how it is used to keep an eye on things inside the unit.

Bill Mikulski (Greektown Casino, Detroit, MI) is back with a look at an interesting new product for Konami belly glass illumination. It's an all solid-state design, edge-lit diffusion panel that is impervious to the slams and crashes of the drop crew that often break CCFLs. Also, being a solid-state lamp system, it doesn't require an inverter.

Ted Befus is back too with more on the Secure Progressive Controller, the successor to the PGI DCU and Con1 and Con2 super controllers. This one unit gives you the ability to control hundreds of games from one single controller.

Sorry, Pat Porath. I can't mention you every month. Oh wait. I just did.

See you at TechFest, October 21-23 2008 at the Sahara Hotel and Casino in Las Vegas, Nevada.

Randy Fromm

Randy Fromm - Publisher

Randy Fromm's
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Out With the Old In With the SPC

By Ted Befus

Ok, for those of you who didn't read my last article on Mysteries of the Nile I will elaborate on the acronym above but first I should say "shame on you" for not reading it.

SPC stands for Secure Progressive Controller and it is the successor to the PGI Data Collection unit (DCU), Con1 and Con2 super controllers. This one unit gives you the ability to control hundreds of games from one single controller (256 games to be exact).

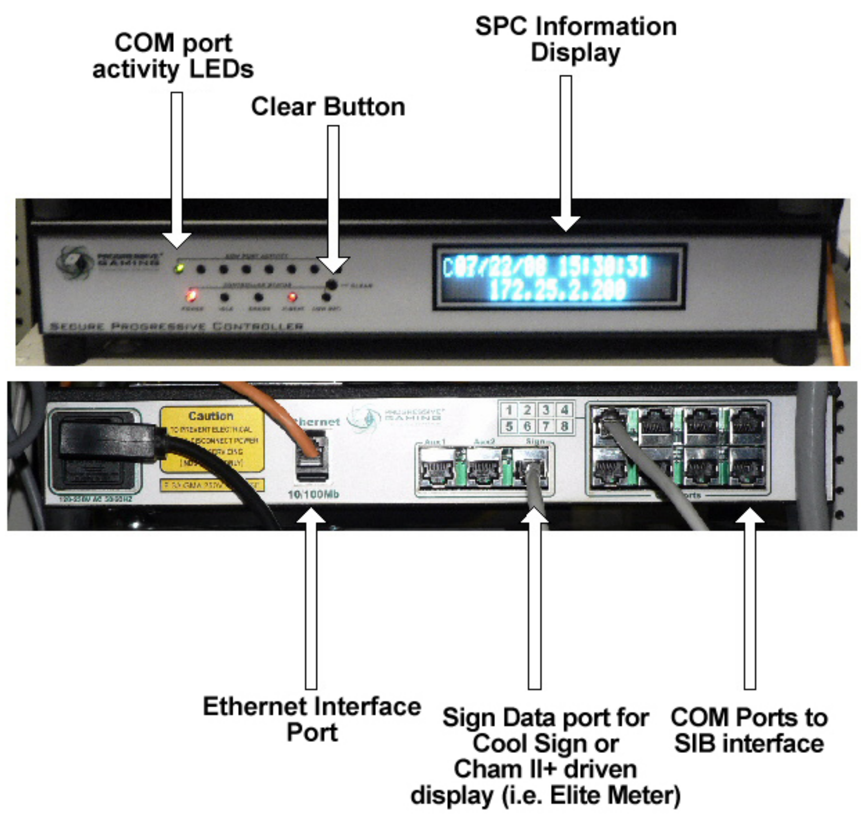
When I started in the industry a little over 12 years ago, the CON2 was heralded as a terrific piece of equipment. It had the capability of handling 30 games on it as a master controller (32 if it was configured as a slave), also the master could talk to up to 15 slaves! WOW! Wasn't that awesome? Then came the DCU. I'll be honest I never really learned much about the DCU. I had one come into the shop once with an evaluation game that I tinkered with but never really became proficient with it. Now after all this time here, we have the new "latest and greatest" from PGI.

For those of you who may be new to this whole progressive thing lets just give you a little bit of a refresher as to what exactly a progressive jackpot is. A progressive jackpot is a jackpot that is increased by way of taking a percentage of each coin played until the jackpot is won. Now in most instances the jackpot is won by a winning combination on the game whether it is the top prize or a lower tier combination. In the case of Mysteries of the Nile® or IGT's Party Time® the win can be random. I don't really call these progressives but they are termed as Mystery Progressives, since the jackpot is still progressed and not a static jackpot.

So to control these jackpots (unless they are of the stand-alone variety, well the SPC can run 256 stand alones, but I won't get into that) you need a controller. IGT makes their own controller to control their progressive (called the IPC, but we're not going into that one here).

So let's get back to the SPC. Like I stated earlier, you can use the SPC to control up to 256 games. This is possible by the use of eight data ports on the rear of the SPC. Each port can support up to 32 games (32X8 = 256) or like I stated it can handle 256 individual stand alone jackpots.

Figure #1 shows the front and



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rear views of the SPC controller (it sure is pretty isn't it?). On the front of the controller you see (from left to right) the COM Port activity LEDs. These display in multiple colours the activity that is on that particular port. (In this photo COM port #1 shows a green LED meaning that there is activity of at least one online game with no errors.) If there were games online with errors the LED will report with a red colour. In the event that the LED is reporting orange ON ONE CHANNEL that indicates that there is at least one game online and there is a pending jackpot. If ALL LEDs are orange that indicates that the controller is not running and is in need of a clear or that the SPC Programming key is inserted.

Underneath the COM port LEDs you will find LEDs for Power, Idle, Error, Heartbeat and Low battery. Those are pretty self explanatory as to their function, with the exception of the IDLE LED. If the LED is lit, you have games online but are currently receiving no increment from them. The heartbeat LED should have a steady state blink at all times.

The clear button is used to clear SPC errors that may occur. You may recall a previous article from some time ago I wrote titled "Yes, another build your own article!" (See the August 2006 issue of Slot Tech Magazine) where I outlined how to build a controller to reset jackpots remotely without the use of a PC. That same box can be used to reset errors on the SPC (believe me it comes in handy). However, there is no input for you to connect to in order to make this happen. In this case, I soldered a set of wires from my control box to the clear switch PCB located inside the SPC. You may want to re-think the active time for the relay on that as well as there is only a short pulse needed to trigger the switch properly.

To the right you see the user display. It will show you pertinent information regarding the controller (date, time, IP or DCHP address as well as how many machines are online and if there are any errors).

If we look at the back you will see the power connector (not labeled, that should be really obvious as to what it is). Next to it you see the ethernet port. The SPC has the capability of being connected to a remote system for programming and auditing using this port with DHCP protocol. If no remote system is available or used, you can set a static IP address and, using a crossover ethernet cable, you can use your computer's web browser to configure and audit this controller. For those of you who have never seen one, a crossover cable has the Tx+, Tx-,Rx+ and Rx- crossed at one end of the cable. See figure #2 for a picture of what it looks like.

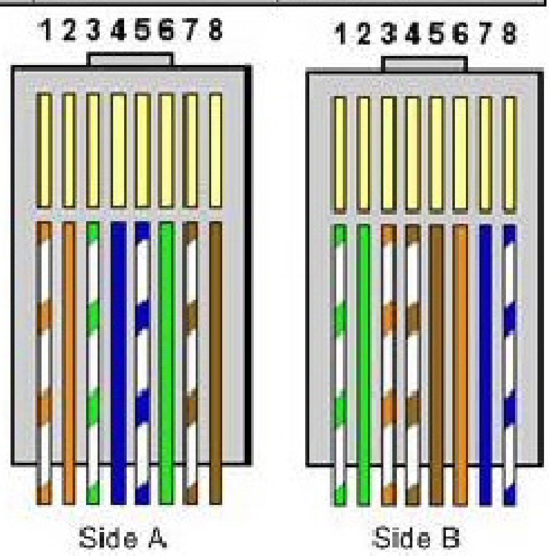
To the right of that you will see three more ports labeled AUX1 AUX2 and Sign. To be honest, I've never used either auxiliary port but according to my manual, they provide auxiliary RS485 data with AUX1 having the capability of doing RS232 as well. The sign port is connected to a progressive display if there is one, however this is port is also RS485 which means you will need a conversion device such as an SIB to talk to your sign (maybe I'll cover that in another article).

Lastly, you see the eight data ports that are to be connected to your gaming machines, via an SIB. Each of these ports can handle 32 games.

Well, that briefly covers the new Secure Progressive Controller from PGI, look for more from me on how to connect games and program this controller in near future.

- Ted Befus
tbefus@slot-techs.com

Pin ID	side A	side B
1	Orange-white	green-white
2	Orange	green
3	green-white	orange-white
4	blue	brown-white
5	blue-white	Brown
6	green	orange
7	brown-white	Blue
8	brown	blue-white



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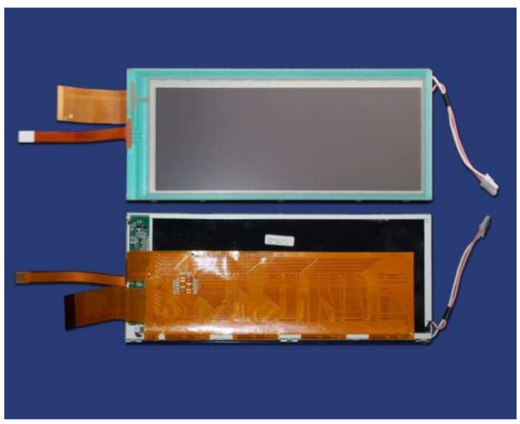

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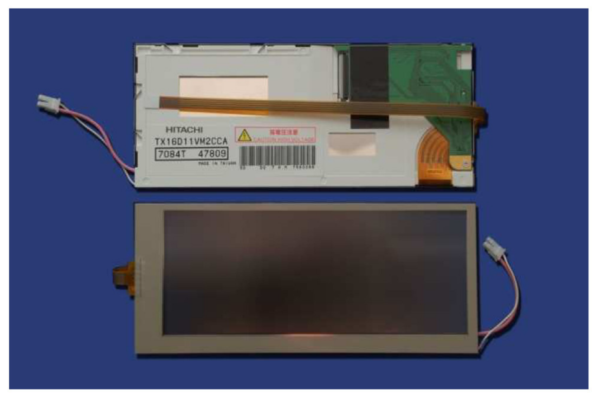

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- Part #9190: Protective Mylar piece for touch screen
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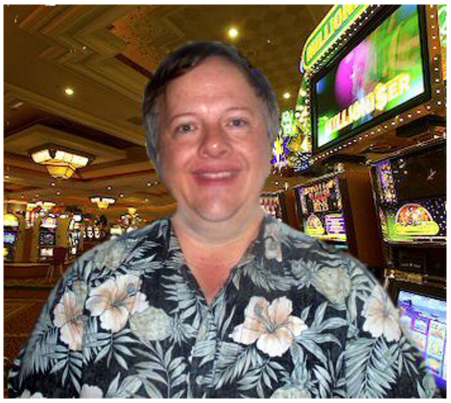

Repair, Send or Toss

By Vic Fortenbach

In most slot repair shops, there is an inventory of spare parts. Most of the time, these parts are organized and inventoried. When a part is needed to repair a slot machine on the floor, the part is removed from the stock shelf and logged or inventoried as "removed." The part is then installed in a slot machine. The bad part gets tagged with general information about the problem and what machine it's from. The item is then placed on the "Bad Parts" shelf for repair. The bad parts are then reviewed and compared with the shelf inventory to determine what needs to be fixed first. If an item count is low on the stock shelf and there are several of the same items tagged bad on the bad parts shelf, that part gets first priority to be repaired.

But what if it takes a long time to troubleshoot and repair a single part? Then a decision has to be made. Does the bench tech spend a lot of time, trouble shooting and repairing that one assembly or part, or could the bench tech use that same time to repair several different items, in the same time frame? It's a tough decision, and one that requires careful thought.

One good example of a slot machine part that requires the use of the decision making process mentioned above, is the Aristocrat MKVI power supply. This power supply is complex, maybe too complex to make troubleshooting and repairs quick and easy. So the bench tech is faced with a problem. Repair it in house, send it out to be repaired by an outside company or just toss it in the trash and buy a new one that is guaranteed to work. If the bench tech repairs the power supply, the time frame to complete the task might be long. If the power supply is sent out for repair, there are the shipping times and costs involved, as well as the cost to repair the power supply that must be considered. Due to the complex design of the Aristocrat power supply, most repairs to the power supply are not just simple capacitor replacement jobs but rather they often require lots of testing and more testing to locate the problem. Once the problem part or parts have been located, the parts will have to be ordered. The parts used are not strange or exotic but additional time may be required to receive the parts if they are not already in stock. Buying a new power supply is out of the question for most casinos, so this is actually not really a practical option.

So only two options are left: you can repair it in house or you can send it out for repair. Because of the complex design of the Aristocrat power supply, my vote is to send out the power supply for repairs. Let the bench tech work on repairing items that can not be sent out for repair but are easy enough to complete in a short time frame. You can send the power supply to one of several places for repair. Aristocrat in Las Vegas will exchange power supplies for about half of the cost of a new power supply. Other companies that are not affiliated with Aristocrat that will repair http://www.digitechsys.co.kr

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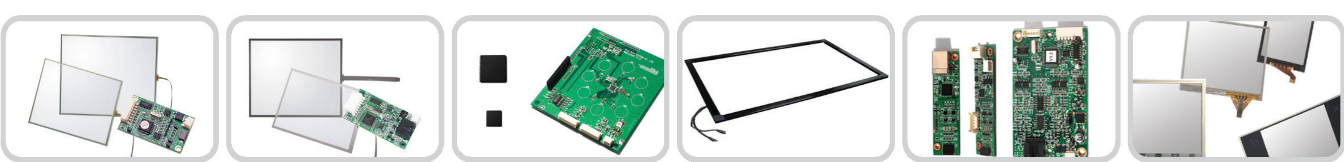

your power supply and ship it back to you. These companies include American Gaming and Electronics (AG&E) and Suzo-Happ. Both service centers have the experience to repair the power supplies quickly, with fast turnaround and at the half the cost of a new power supply.

IGT ballasts are another good example of toss, send or repair. The small, white and square (or faded yellow) IGT ballasts are cheap; they can be purchased for less that $15.00 new. Because of their small size and minimum parts, there is no place that you can send them out for repair but they can be repaired in-house easily. Using six parts that cost less than $3.00 and 15 minutes of repair time, non working ballast can be repaired. Slot Tech Magazine featured an article in the March 2006 issue on how to repair the IGT ballasts. If you do not want to find each part individually, Suzo-Happ sells a kit with all the parts required to rebuild the IGT ballasts. This kit can be purchased for less than $3.00. The repair kit's part number is 70-1337-00. Unfortunately, some casinos have the attitude that you can not repair the IGT ballasts and have them work reliability. Their idea is to just toss them and buy new. If you break down the cost of buying a new ballast (about $15.00 plus shipping) versus the time (15 minutes) and minimal parts (six) to repair the ballast, repairing the ballasts will always be victorious, especially in quantities. As for reliability, yes, some repaired ballasts will fail after a repair. But repairing them in house is still a money saver.

The external fuse that is used with the older IGT ballasts is also on the list of repair, send or toss. This small assembly is just a circuit board with male and female connectors on each end and two polymer fuses mounted on a circuit board all protected with heat shrink tubing. This fuse assembly protects the 25 volt line of the IGT slot machine in case the ballast shorts out. These external fuses are now obsolete, since the newer IGT ballasts already have them built inside the plastic ballast case. Since these little fuse assemblies were used in the beginning, they are still around and do need repair when they fail.
This fuse assembly is not an actual glass fuse but a device that is called a polymer fuse (the name is shortened to poly fuse in general conversation). The poly fuse is light brown in color with two wire leads coming out of the bottom for circuit connection. Since the poly fuse is a solid color, there is no way to visually tell if the poly fuse is bad. You have to use a multimeter to check it. Poly fuse components are cheap and can be purchased in quantity. Since the fuse assembly can not be sent out for repair, you must repair it or toss it. Since the part is small, the mind set is "just toss it, it's easier than repairing them." If you do decide to toss it, you can but new ones from Suzo Happ for less than a dollar each, plus shipping. The Suzo Happ part number is RUEF090.

It's a constant challenge for any casino to save money and one way is to make smart decisions on which parts to repair, send or toss. There is one part used on a slot machine that has to be tossed. It can not be repaired, or sent out for repair, which part is it? The light bulb!

- Vic Fortenbach
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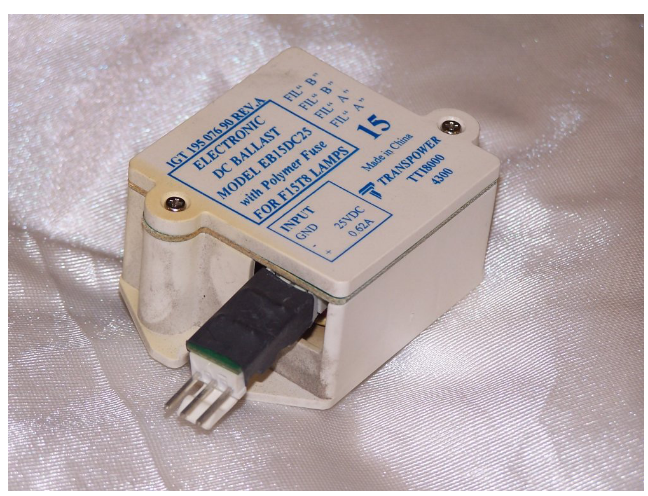

IGT Ballast and poly fuse

With a Compelling Title Like This, You Just Can't Help Reading:

MK5PFC Circuit Analysis Part 2

In part one last month, we looked at the PFC half of the UCC38503 combination PFC/PWM controller IC. Let's start part two by looking at the other half of U14. I guess I'd have to say that this is the only "boring" part of this power supply. The PWM controller part of U14 is totally normal in every respect. Pin 10 is the "Gate 2" output that controls MOSFET Q5, the primary switching transistor that switches the primary current on and off through the primary winding of power transformer T1. Totally normal.

You can see the typical regulation feedback provided by the transistor half of an opto-isolator (U4) and you can see that the LED half of U4 is powered by the +24 VDC output of the supply with a frequency-compensated TL431 (U9) providing a nice reference voltage on the cathode of the device.

We light up the LED in the opto-isolator with voltage from the secondary output of the power supply. The higher the voltage, the brighter the LED shines. We read the brightness of the LED with the phototransistor in the opto-isolator, which is connected to the PWM control circuitry in U14 on the primary side of the transformer. In this way, the secondary can "talk" to the primary without actually touching it.

But in order to maintain tight voltage regulation, we need to go just one step further. We need to control the brightness of the LED under a variety of changing load conditions of both high and low frequencies. There is another element in the chain of regulation and in this case it's U9, a type TL431. Get to know the TL431 because there are four of them in this power supply.

You can think of the TL431 as a sort of programmable Zener diode. It is a "shunt regulator" that can be programmed to be any voltage from a minimum of 2.5 volts to a maximum of 37 volts. Inside the device, an internal 2.5 volt reference is compared to the voltage that is applied at the reference pin input. This reference voltage is derived by a resistor voltage divider (R96, R97, and R100). The TL431 provides the gain that is needed at low frequencies so that the LED in the opto-isolator will produce enough of a change in brightness in order to signal the primary side and compensate for the low frequency changes in the load.

But this gain is not needed at high frequencies. The gain of the opto-isolator itself (the CTR or current transfer ratio) works just fine, without any assistance from the TL431's gain, thank you very much. This leads to a sort of engineering dilemma where high frequency changes in load can produce larger voltage swings than low frequency loads, making tight regulation impossible.

Compensation

In this case "compensation" is "frequency compensation" which is the way we can control the frequency response of various circuitry. By using a combination of resistors

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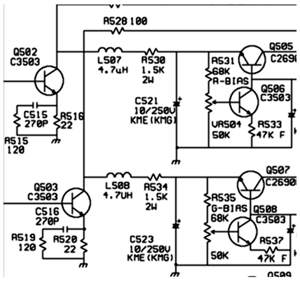
SCHEMATIC DIAGRAMS

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.

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and capacitors primarily, we can integrate the various load frequencies and "tell" the TL431 how to behave at certain frequencies. In this power supply, the compensation network is made from C119, R103 and C89, a 1 uf, bipolar capacitor. The compensation network allows the TL431 to maximize its contribution at very low frequencies and to remove its influence at higher frequencies. The connection of C89 and R103 between the cathode and the reference terminal of the TL431 allows maximum loop gain at DC for the best voltage regulation.

What else can you say about this totally normal SMPS design? The output of power transformer T1 is rectified by D30 and filtered by C88 (2200 mF 35 V). After passing through a choke (L8), C106 (also 2200 mf 35V) provides additional filtering. At the same time, of course, C88 and C106 are "reservoir capacitors" that, along with the energy stored in C52 (the primary filter capacitor) will be all the energy that the power supply has in case of a power failure.

Cut the Juice, Bruce!

Do you remember the Low Power signal from last month? Remember that the Low Power signal must be dragged to ground in order to energize the monitor AC power. Well, the Low Power signal is doing something else at the same time, something sort of unrelated (electronically speaking) to monitor control but something that a slot machine needs to take care of and that is surviving a blackout. In the case of an immediate and unpredicted loss of AC power, a slot machine has some serious business to attend to before the energy stored in the power supply's electrolytic filter capacitors is fully dissipated. Mostly, the CPU simply has to store a small amount of data (things like customer credits and current game condition) and perform an orderly shutdown but in some cases, the slot machine might even want to run long enough to continue to increment the hard coin meters (the electromechanical units themselves) until the correct count is obtained.

The MK5PFC makes this possible by quickly shedding some of the +24 VDC load and it does it with a remarkable little device called a UCC3913 Negative Voltage Hot Swap Manager, also known as a circuit breaker! Both of these terms are familiar to us, of course. We know all about hot swapping (and the damage it can cause in a slot machine) and a circuit breaker is, well, a circuit breaker.

When the Low Power signal (it comes from the slot machine, remember?) goes high, the LED in U1 on the filter board turns off. We covered that in part one. But what we didn't cover is where the LED in U1 gets its power source at the anode. This is very clever. Let's look at the entire control circuit.

U13 is the UCC3913. Let's follow the green path. This is the +24 VDC power bus. It's the output from the secondary winding of T1, rectified by D30 and filtered by C88. It's the actual output of the power supply, its Raison d'être. The +24 VDC bus is connected to the florescent lamps at connectors X7 and X8, pin 4. However (and here comes the interesting part) we need a return path to complete the circuit for the florescent lamps. The return path is through pin 2. Follow the checkered green path, remembering as you do that this is the return path and we're headed for ground somewhere, the shorter the path (least resistance) the better. In this case, the shortest path (the only path) is through MOSFET Q7 and its source resistor R236 (just 15 milliohms used, naturally, for over-current sensing) to ground.

Naturally, Q7 has to be turned on for this to happen and you can see where all this is headed. U13 is the thingy that controls the gate voltage of Q7. Obviously, U13 has to have power in order for this to happen. That power source (Vdd-pin3) comes from the +24 VDC bus through transistor, Q6. It's a PNP transistor with its emitter connected to the +24 VDC bus and its base (which must be dragged down in voltage in order to energize Q6 because it's PNP) connected to—TA DA!—the Low Power signal! That's an interesting connection between the circuit that controls the monitor AC and the circuit that controls the florescent lamps. At the same time that the Low Power signal is lighting the LED in U1 (thus controlling the monitor) it is pulling down the voltage at the base of Q6, shooting the power source to U13 which energizes Q7, completing the return path to ground and lighting the florescent lamps.

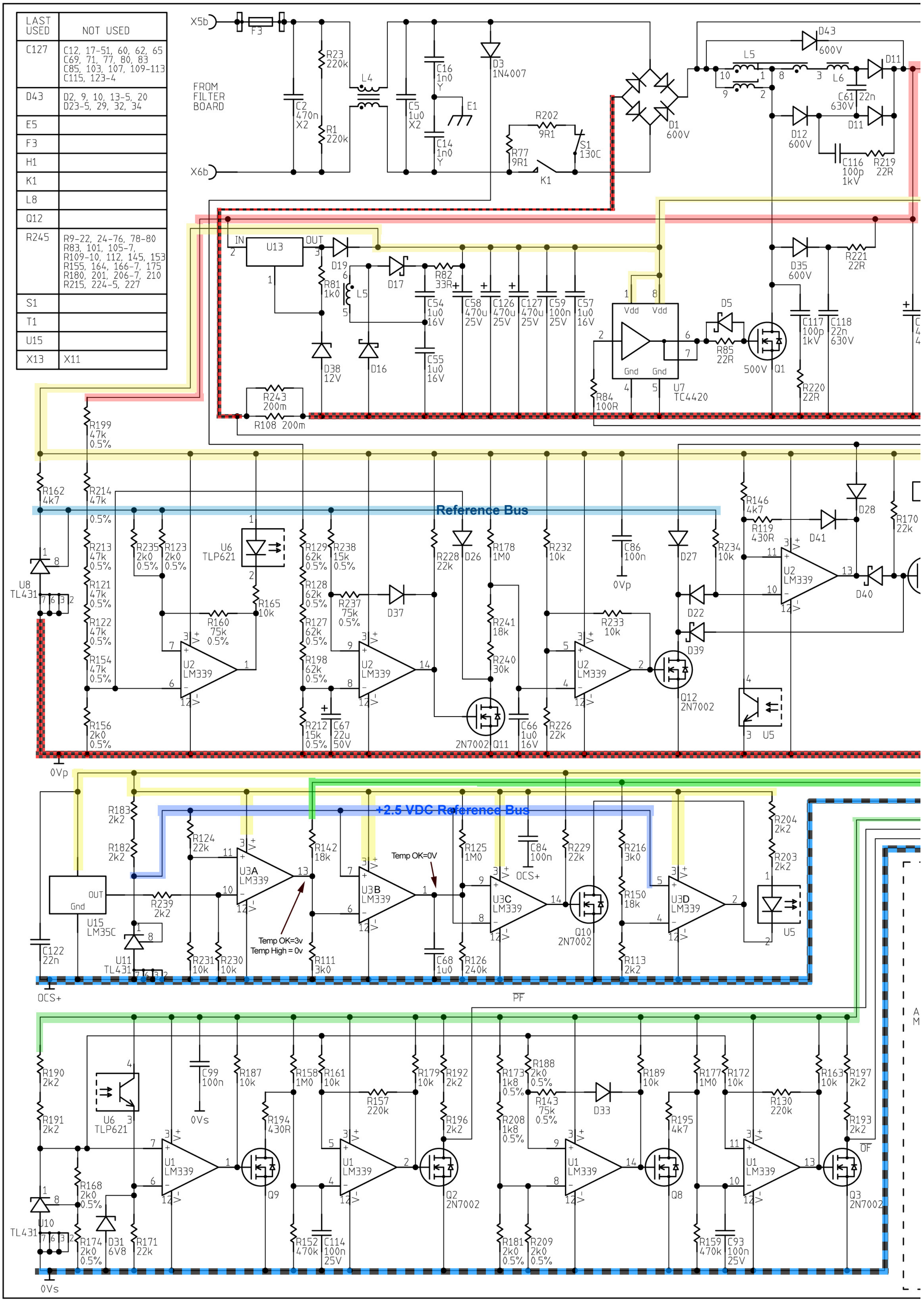
In the case of a power failure, the Low Power signal goes high. This instantly shuts off the TRIAC providing AC power to the monitor (which at first glance seems sort of silly since there actually is no AC at the moment but it's part of the whole load control circuit) and, at the same time, turns off the florescent lamps. By shedding some of the load from the +24 VDC power bus, the energy stored in the power supply will be sufficient to take care of business before everything decays to zero.

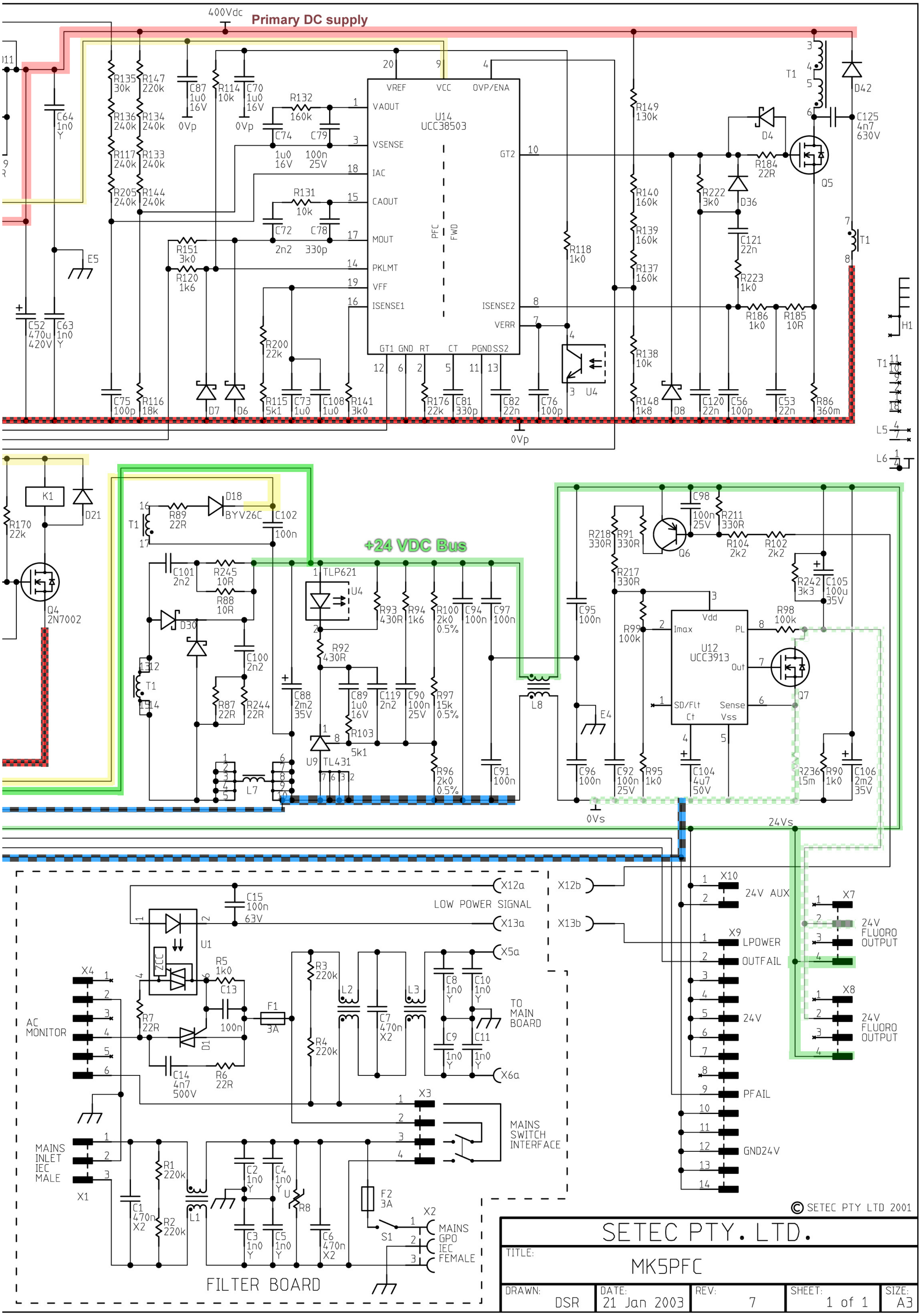
Correction

Actually, it's more of an addendum but I admit to an error in last month's discussion of U13, the type VB408. I had mentioned that the output current is limited to just 40 milliamps but mentioned that it was enough to power the few low voltage things we need to operate before the main power supply output comes on line. It is not. Not without some assistance. What I had failed to mention is a pretty darned clever little part of this "power supply within a power supply."

If you recall from last month, coil L5 is an energy storage device used in the PFC circuit. We looked at L5 as part of the PFC

LAST USED	NOT USED
C127	C12, 17-51, 60, 62, 65 C69, 71, 77, 80, 83 C85, 103, 107, 109-113 C115, 123-4
D43	D2, 9, 10, 13-5, 20 D23-5, 29, 32, 34
E5	
F3	
H1	
K1	
L8	
Q12	
R245	R9-22, 24-76, 78-80 R83, 101, 105-7, R109-10, 112, 145, 153 R155, 164, 166-7, 175 R180, 201, 206-7, 210 R215, 224-5, 227
S1	
T1	
U15	
X13	X11




400Vdc
Primary DC supply
U14
UCC38503
VREF
VCC
OVP/ENA
VAOUT
VSENSE
IAC
CAOUT
MOUT
PKLMT
VFF
ISENSE1
GT2
ISENSE2
VERR
GT1 GND RT CT PGND SS2
PFC
FWD
0Vp
T1
D42
C125 4n7 630V
Q5
D4
D36
D7
D6
D8
U4
H1
+24 VDC Bus
K1
D21
Q4 2N7002
D18 BYV26C
C102 100n
TLP621
U4
U9 TL431
L7
L8
Q6
U12
UCC3913
Imax
Vdd
PL
Out
SD/Flt
Ct
Sense
Vss
Q7
E4
E5
0Vs
24Vs
X12a
X12b
X13a
X13b
LOW POWER SIGNAL
U1
X5a
X6a
TO MAIN BOARD
AC MONITOR
X4
F1 3A
MAINS INLET IEC MALE
X1
X3
MAINS SWITCH INTERFACE
F2 3A
S1
X2
MAINS GPO IEC FEMALE
FILTER BOARD
X10
24V AUX
X9
LPOWER
OUTFAIL
24V
PFAIL
GND24V
X7
24V FLUORO OUTPUT
X8
24V FLUORO OUTPUT
© SETEC PTY LTD 2001
SETEC PTY. LTD.
TITLE:
MK5PFC
DRAWN: DSR
DATE: 21 Jan 2003
REV: 7
SHEET: 1 of 1
SIZE: A3

circuit but there is yet another winding on L5, wound around the same toroidal ferrite core. It's connected to pins 5 and 6 and can be found on the schematic diagram just to the right and below the voltage regulator, U13. Once the PFC circuit kicks in (and Q1 is operating) there is a ton of energy in L5. The winding between pins 5 and 6 simply picks up some of this energy. Sounds like a transformer, doesn't it? For all intents and purposes, it is. It's just a really cool and efficient, high-frequency, toroidal transformer that keeps all of its precious energy tightly held within its donut-shaped core until we tap into it when we need to.

And we need it now. Once the PFC circuit has kicked in, we take this low voltage output from L5 and rectify it with D17. From there, the current passes through R82 and onto the power bus. Diode D19 prevents the current from flowing backward when the output voltage of this little "supply within a supply" is greater than the output voltage of the regulator. Also, we can't allow the output voltage of U13 to exceed the input voltage as can occur when the main AC power is removed. The primary filter capacitor can (will) discharge faster than the secondary filter capacitors because it uses the last bit of its energy charging them! In general, voltage regulators don't do well when the output voltage exceeds the input voltage.

By their Grounds Ye Shall Know Them

As with all switched-mode power supplies, it is very important to realize the isolation between the primary circuits and the secondary circuits. In this power supply, there is quite a bit of low-voltage circuitry connected to the primary return (0v) which is totally and completely isolated from the secondary ground! This "hot return" (meaning that although it represents a common return path (0v) for all of our primary circuitry, it is hot in respect to Earth ground) is marked on the schematic diagram with a black and red checkerboard pattern. When you are making voltage measurements in the primary, you must have your meter ground connected to the proper point. If you are using an oscilloscope, you must have the power supply plugged into an isolation transformer before connecting your 'scope ground to this point or you will vaporize portions of both the power supply and the oscilloscope ground.

The "cold return" is the secondary ground. It's marked on the schematic with a blue and black checkerboard. This is totally normal and connected to all of the grounds throughout the slot machine, including the Earth ground and all DC grounds everywhere.

As you look at the two return paths (the primary, with its red checkerboard and the secondary in blue) the schematic diagram sort of resolves itself and you can more readily visualize that the circuits in the lower left hand corner of the schematic (U1, U3 and associated components—they're fault detection circuits that we'll get to shortly) actually belong on the right side of the schematic (to the right of the secondary winding of power transformer T1) if you wanted to follow hard and strict rules of drawing inputs (the primary circuits) on the left and outputs (the secondary(s)) on the right. Once you realize that, it's much easier to visualize how the circuits actually operate and the schematic diagram is way less intimidating. Of course, there is no way to draw the schematic that way in any sort of acceptable aspect ratio. It would be way too wide. Honestly, it's a miracle the engineers were able to fit it all on one page and it is, in fact, a very well-drawn schematic diagram. I've just made it even better by adding the colored busses so we can identify, at a glance, the overall structure of the unit.

Fault Detection and Protection

We want to keep an eye on a few different functions. We certainly want to look at the output voltage to make sure it doesn't go too high. If something fails and the 24 VDC output climbs as high as 28 volts, we want to do something about it (pronto) before anything becomes damaged. Likewise, if the output voltage drops below 22.5 VDC, we'd like to know that as well. It's not likely to cause any damage but if the voltage is dropping, we will want to start shedding loads and at the same time, inform the CPU so it can start an orderly shutdown. We also measure the internal temperature as well (you'll see why in a minute). All of these are analog measurements but we really don't need to measure these actual values so much as we simply need to know when we have crossed a preset threshold. As long as the output voltage is between 22.5 and 28, we really don't care what the actual voltage is.

This comparison between two values (our sampled value and the preset) perfectly describes the function of a comparator and that's what U3 is. It's an LM339 quad comparator. The "quad" part means that there are actually four identical comparators in a single package so what appears at first to be four individual devices is really just one component.

In a single-ended configuration like this one, its operation couldn't be simpler. There are two inputs and one output. The two inputs are labeled + and -. The + input is also known as the "non-inverting input" while the – input is also called the "inverting input." The LM339 compares the two voltages at the inputs. If the – input is a higher voltage than the + input, the output pin goes to zero volts (the voltage at pin 1).

However, rather than thinking of it as "putting out zero volts" it's much better to think of the output as what it really is, a connection to ground. It's an open collector output, Q8 on the schematic of the comparator. When the – input is higher in voltage than the + input, the comparator is “activated” and the output is connected to ground through the transistor. Anything connected to the output pin will become grounded. It is a “current sink.” It is NOT a current source.

On the other hand, if the + input is a higher voltage than the – input, the output pin essentially becomes disconnected from everything (Q8 is turned off) and will be just swinging in the breeze with its open collector. Of course, the voltage on the pin will swing up to the voltage determined by what ever pull up resistor or resistor voltage divider network we have on the output. We don’t really even care what this voltage is all the time. We can often just think of it in digital terms as being “high” or even just “not grounded” and leave it at that.

With this concept firmly in place, let’s start on the left side with U15, the LM35C Temperature Sensor. This power supply has an internal temperature sensor that is part of the over-current protection system. It’s is a really great place to see the comparator in action. In a nutshell, if too much current is drawn from the power supply for an extended period of time

National Semiconductor

LM139/LM239/LM339/LM2901/LM3302
Low Power Low Offset Voltage Quad Comparators

LM139/LM239/LM339/LM2901/LM3302 Low Power Low Offset Voltage Quad Comparators

General Description

The LM139 series consists of four independent precision voltage comparators with an offset voltage specification as low as 2 mV max for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, squarewave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, they will directly interface with MOS logic— where the low power drain of the LM339 is a distinct advantage over standard comparators.

Advantages

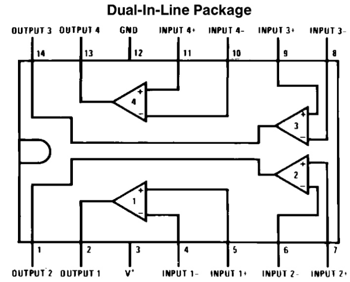
- High precision comparators
- Reduced V_{OS} drift over temperature
- Eliminates need for dual supplies
- Allows sensing near GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

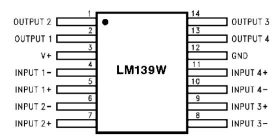
Features

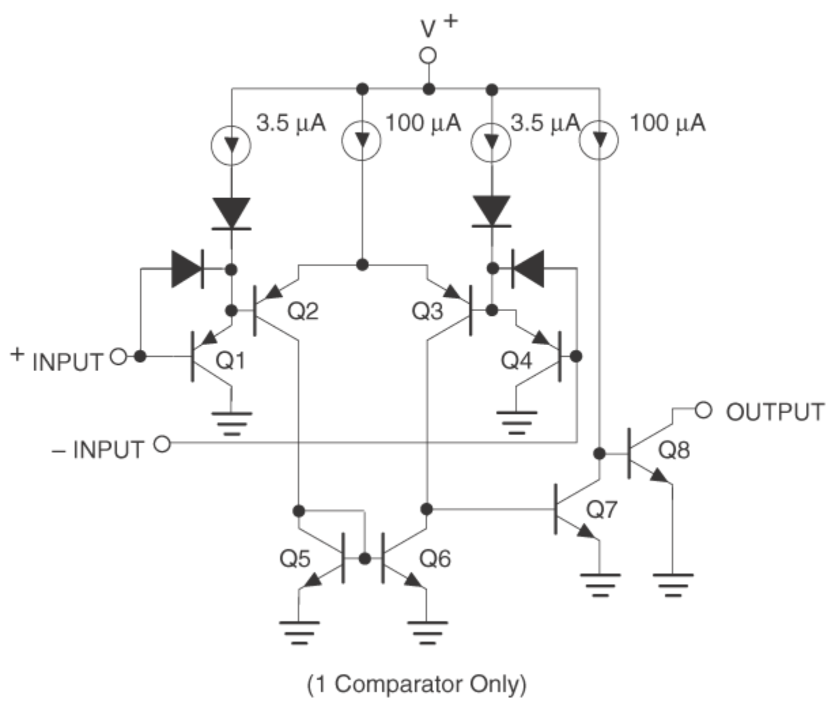
- Wide supply voltage range
  - LM139 series, 2 V_{DC} to 36 V_{DC} or ±1 V_{DC} to ±18 V_{DC}
  - LM139A series, LM2901 2 V_{DC} to 28 V_{DC}
  - LM3302 or ±1 V_{DC} to ±14 V_{DC}
- Very low supply current drain (0.8 mA) — independent of supply voltage
- Low input biasing current 25 nA
- Low input offset current ±5 nA and offset voltage ±3 mV
- Input common-mode voltage range includes GND
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage 250 mV at 4 mA
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

Connection Diagrams

Dual-In-Line Package







Inside the LM339 Comparator

(causing the power supply to overheat) or if the machine is operating in an environment that exceeds the maximum temperature rating (causing the power supply to overheat) we want to turn off the power supply. U15 has just three leads: a power supply input, a ground and an output. Want to guess how it works? If you said "the output voltage changes with temperature" you're right. It operates in a range of -55 to +150 C. The higher the temperature, the higher the output voltage (it rises at 10 millivolts per degree Centigrade). You can see the output is connected to pin 10, the – input of the LM339, U3A.

For the other input to the comparator, we generate a +2.5 VDC reference voltage using a TL431. This reference gives us a precise and unchanging voltage to which we can compare other voltages. In this case, we set the "trip" level of the circuit with a voltage divider made from R124 and R231.

As long as things are cool, the – input voltage is lower than the + input and the

National Semiconductor

LM35/LM35A/LM35C/LM35CA/LM35D Precision Centigrade Temperature Sensors

LM35/LM35A/LM35C/LM35CA/LM35D Precision Centigrade Temperature Sensors

General Description

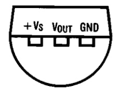
The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-202 package.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±¼°C typical
- Low impedance output, 0.1 Ω for 1 mA load

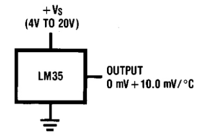
Connection Diagram

TO-92
Plastic Package



BOTTOM VIEW

Typical Application



TL/H/5516–3

FIGURE 1. Basic Centigrade Temperature Sensor (+2°C to +150°C)

comparator output sits at about 3 volts (R142 and R111 form a voltage divider that does this). However, if it becomes too hot inside the power supply, the voltage at the – input will exceed the reference voltage at the + input and the output at pin 13 will go to ground.

This low signal is felt at the – input of U3B at pin 6. The + input of U3B is tied directly to the 2.5 VDC reference voltage so as the – input drops from 3 volts to zero, the output voltage of U3B (pin 1) swings high. This signal is connected to the + input of U3C at pin 9. As the voltage rises from 0 (which is what it will be if the temperature is OK) and passes the +2.5 VDC reference (connected to the – input of U3C at pin 8) it will trigger the output of U3C at pin 14 to go high as well. As you can see, the output of U3C is connected to the gate of MOSFET Q10 so this high signal will turn on the device.

Please remember that what is REALLY happening here is that the gate of Q10 is normally HELD DOWN TO ZERO VOLTS by the ACTIVE output of U3C. It is only when the temperature RISES that the output of U3C goes high (meaning its internal open collector transistor is now turned off) and the gate is allowed to be pulled high by resistor R229. This "negative logic" is carried out throughout the design of this power supply. The active devices are almost never sourcing current (Q6 being the notable exception as it sources the Vdd for U12). The current source instead comes from some sort of power bus, through a resistor or some resistors as a voltage divider. We shunt this current to ground (or 0 volts or whatever you want to call it here) when the comparator's – input voltage exceeds the voltage at the + input.

So, after all of this, here is where we stand: If the temperature is normal, Q10 will be off. If it gets too hot, Q10 will be turned on.

What is Q10 doing and why is it so important in this chain of events? The drain of Q10 is connected to the cathode of the LED in opto-isolator U5. When Q10 turns on, the LED lights up. Directly above the LED half of U5 is the phototransistor half of U5, connected (as you can see by the red checkered return path) to the primary side of the power supply. Now we're getting somewhere because we have not only detected the high temperature condition but we have a way to tell the primary side of things (where all the action is!) that we have a problem and that it might be a really good idea to shut down before things get any hotter.

So turn your attention now to the phototransistor half of U5 and the + input of U2 to which it is connected. As you can see, if the phototransistor in U5 is turned on by the light from the "high temp" LED half of U5, it's going to drag the + input down to zero volts and, since the – input will now be higher in voltage than the + input, the output of U2D at pin 13 will go low. This will drag down the gate of MOSFET Q4, turning it off and when that happens, finally, at long last, we arrive at the final goal of this circuit.

When Q4 is turned off, the relay, K1, drops out. Do you remember K1 from part one of this discussion? Relay contact K1 shorts out the 18.2 Ohms of series resistance on the AC input. If the temperature rises too high, the relay drops out and the power supply enters an operating mode that places resistors in series with the AC input once again.

Next month, we'll see how the power supply responds to this crisis. We'll see how it detects the drop in voltage and how it alerts the slot machine that something is amiss in time for the slot machine to button up shop and shut down. - **STM**

Konami LED Belly Lamp Replacement Kit

By Bill Mikulski

It's nice to see the game manufacturers putting their attention not only in the software design but also in their cabinets. Here at GreekTown Casino in Detroit, Konami is one of our most highly played games, especially in the lower denominations. I believe this is in part due to their many years of experience in the video game industry.

I especially like the design of the new K2V 2.0 cabinet. When I first looked inside one of these games, one of the things in the design that I couldn't help but notice was the thin design of the belly door. I was curious what the light source was. It was a clean white light. I found this light panel even more interesting after taking a closer look. I've been doing more work with LCD monitors and Cold Cathode Fluorescent Lamp (CCFL) devices in the last two years or so, and after a closer look I realized that this belly light panel was simply a back light design the same as that used in LCD monitors where a CCFL is used to light the edge of a diffusion panel. I thought this was pretty cool. If you haven't taken an LCD monitor apart, you can take a closer look at this belly lamp. It is exactly the same backlighting you would find in a LCD monitor, which is approximately a quarter inch plastic plexiglass, with two CCFL lamps placed at the bottom, a reflective Mylar plastic coating on the back to reflect the light forward, and one inverter board to power the lamps. The inverter uses a +12 VDC power source.

Here at Greektown Casino, our games (especially the belly door) take quite a beating. And this beating is not always from a guest who has lost their money but sometimes from employees. Here at the casino, our drop team (the team that collects the cash cans in the evening and changes them out) can sometimes be rough when pulling and returning cash cans. A lot of belly doors are being slammed and abused. One more plus for the Konami belly door is that they use a sheet of plexi, rather than most of the manufacturers who use glass so we are not dealing with broken belly glass any more. Unfortunately, we now have broken belly lights and to repair this CCFL lamp is more expensive than replacing the glass.

Two factors cause these lamps to go out. 1. After time, the lamps get brittle & fragile due to heat (despite the name "cold cathode" there is, in fact, heat generated by the lamp. The name is derived from the fact that the cathodes do not require heating to start as with conventional florescent lamps). The lamps are very thin (2.6mm in diameter) and are easily broken. 2. The CCFL inverter that comes with the game for lighting the CCFL is a very bare bones inverter and is prone to failure.

I have been working more and more on different projects that use cold cathode lamps such as Bally I-View and other LCD monitors. This put me in touch with CI Innovations, where I met Harry Iversen, and Jake Cole. Harry and Jake own CI Innovations and are always willing to help us with issues we have with these types of products. I've learned many things about these products and one of the big factors is quality. All of the original cold cathodes that come with the games have a short life span because of the lack of quality of the cold cathode which is produced in the Far East. After replacing ten of these CCFL belly lamps, Harry told me of a new LED back light that he was working on for another project and mentioned to me that he might be able to adapt this LED light panel to a Konami belly lamp. After a couple of weeks Harry said he had a prototype and asked me if I would like to test it at our casino. Of course, I said yes. I love tinkering with the latest technology as most techs do. I was very impressed once I received the LED edge-lit belly panel. After seeing it, it looked quite simple with LEDs on both sides of the panel. There are many benefits of having an LED light source in this application. One of the main factors is the durability of this panel. It is shock resistant and you cannot break it. In other words, it can take a licking, and keep on ticking. And also, the longevity of the LEDs is 50,000 hours MTBF. These were the two issues where we were having problems with the CCFL light panel. The LED edge-lit panel is powered by 12 volts directly, so there is NO inverter, ballast or AC Adapter needed to run the LED panel. You just connect the wires on the LED panel to the 12 volt input wires that are already there in the machine and you are done. I first fired the LCD light panel up on our bench and was very impressed with the even light across the panel. It was a clean white light.

I was curious how this thing would install. I found it to be a very simple installation. Approximate time for total installation for my first time, right out of the box, was 15 minutes. One of the things that made this installation so simple was that everything you need comes with the light panel. Provided in the kit was the exact 12 volt connector that Konami uses with their belly light so you simply use their same Molex connector as shown in the illustration. Two pieces of Velcro hold the light panel in place. The reason the Velcro is used is because there is no need for any other screws at this point. Once the panel is back in place,

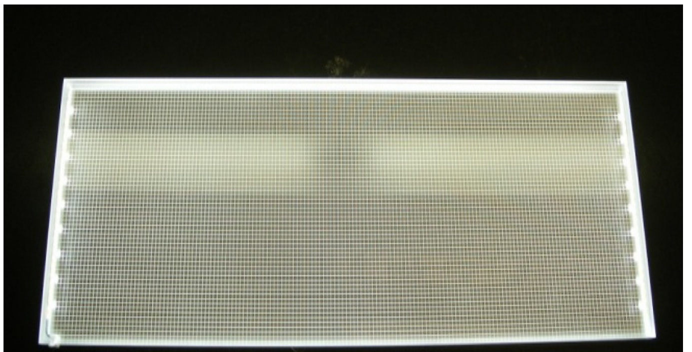
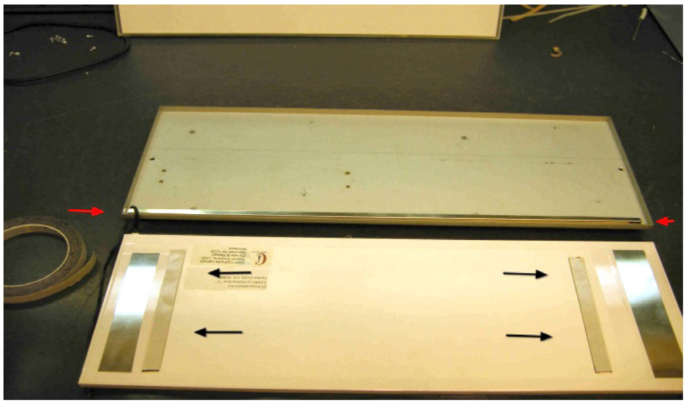
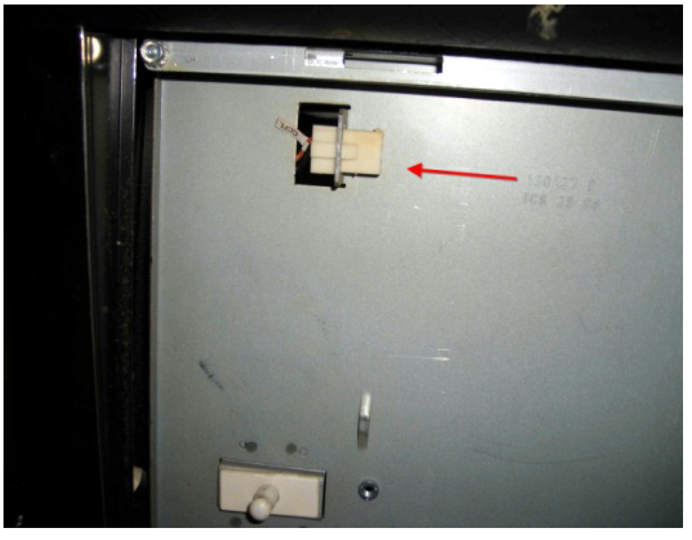


Figure 1 - The new LED edge-lit diamond cut acrylic panel by CI Innovations, Inc





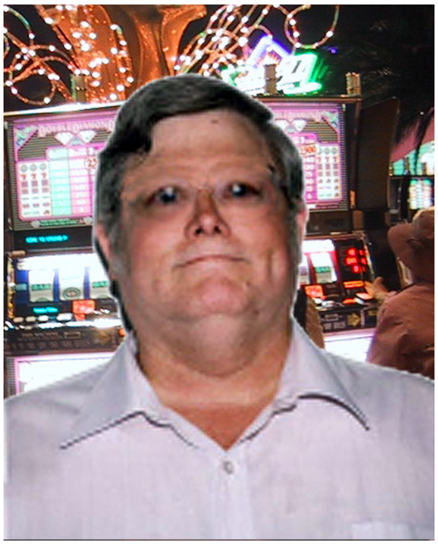
it is wedged between two brackets that hold it in place. The Velcro is simply used so that is does not flop around during installation. It is recommended to leave the CCFL light channel in place and simply remove the old wires. I had a belly light panel in the shop already, ready to swap out the LED light panel, which I must say is a very easy installation. You could almost say it was a plug and play installation, using the same 12 volt source that the CCFL belly lamp used.

So the real test is "how does it look on the floor?" I installed it next to a Konami that had new replacement lamps, which they (CI) also carry. I wanted to compare the two.

The picture on the left is cold cathode lamps, and the picture on the right is the LED. And, I must say I was very impressed with this product. As I said, Harry and Jake are always willing to help with any issues with LCDs , cold cathode lamps & LED light source products, and I am sure they would do the same for you. I know even if you had questions about how things worked and gave them a call, they would be willing to help. It is nice to have people and companies like CI Innovations that are willing to answer your questions. They are extremely knowledgeable in this area and I know they wouldn't mind answering any of your questions. This belly lamp light panel is now available to the public. You may contact CI Innovations for pricing.

Remember to have fun, that's our business.

Slot Tech Bill
- Bill Mikulski



Bad Dots!

By Herschel Peeler

Problem: Video screen has bad dots.

While giving a tech a lesson in how video games work we came across some poker games with off color dots on some of the cards. I had just finished explaining the basics of video game design.

The picture we see on the screen comes out of Video RAM. A Video processor constantly reads Video RAM serializes it and sends it out to the display as five basic signals; red, blue, green, vertical sync and horizontal sync. The contents of Video RAM come from Graphics EPROMs. Typically we have background information that doesn't change much during the game. For a poker game, this is the basic screen layout, the shape and placement of the cards, etc. The foreground information changes with the game itself; specific cards displayed, points accumulated, etc. The random number generator gives us a set of 52 numbers (for 52 cards). Each number specifies a card stored somewhere in an EPROM.

The obvious question is how can you tell where the problem is regarding our bad dots on the screen. If we physically move the whole screen using the screen position controls on the monitor and the dots stay in the same physical position on the screen then the problem is bad dots of phosphor on the screen. If the bad spots move with the card images then the problem is electronic and is MPU board related.

If the bad dots keep the same positions relative to card position no matter what card is displayed then the problem is Video RAM.

If the bad dots show up in the same positions on the same card no matter where that card shows up then the problem is in the card image in EPROM.

- Herschel Peeler
hpeeler@slot-techs.com

Slot Tech Magazine's TechFest 18
Las Vegas, Nevada - October 21-23, 2008

Schedule of Events

Events subject to change

Tuesday, October 21st, 2008

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

Video slot monitors are a lot easier to fix once you know how they work. This session assumes that you have no previous knowledge of monitors. Some understanding of electronic components will be helpful but is not a prerequisite.

12:00pm - 1:15pm
Luncheon

1:15pm - 3:15pm
MEI - BV troubleshooting and repair

Advanced Electronics Systems' **(AESI)** service technician David Oldham will discuss BV operation and service. Troubleshooting guides and handouts will be presented to help speed through troubleshooting in the shop.

3:15pm - 3:30pm
Afternoon Coffee Break

3:30pm - 5:30pm
FutureLogic Printers

Advanced Electronics Systems' **(AESI)**service technician David Oldham will discuss FutureLogic printer operation and service.

Wednesday, October 22nd, 2008

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

Now that we know how monitors work, let's take a look at each of the seven sections that make up a monitor. Once you understand what each of these sections does, monitor failures are easily identified.

It's also time to look at the schematic diagrams for the monitors we find in today's slot machines. Circuits and components are identified with emphasis on "what fails." Each person attending TechFest will come away with a package of schematics and troubleshooting flowcharts that will help speed monitor troubleshooting and repair in the shop.

12:00pm - 1:15 pm
Luncheon

1:15pm - 3:15pm
3M Touchsystems - Touchscreen Technology

It is really amazing how touchscreens actually operate. During this session, touchscreen theory of operation will be presented along with diagnostic and repair techniques.

3:15pm - 3:30pm
Afternoon Coffee Break

3:30pm - 5:30pm
Choosing and Using Sophisticated Test Equipment for LCD and Power Supply Repair (and more)
Presented by Sencore

Regular readers of Slot Tech Magazine know that Sencore makes some of the best test equipment in the industry. This quick tour will discuss the advantages and capabilities of a wide range of test gear for the slot shop's bench tech.

Thursday, October 23rd, 2008

9:00 am - 12:00pm
Ceronix

Armed with a general knowledge of how monitors work (and how to fix them when they don't) it's time to look at Ceronix. The Ceronix design is unique in the entire world and requires a bit of specialized knowledge in order to be successful at repair.

LCD Monitor repair will also be covered. Ceronix's most experienced bench tech, Troy Nofziger will instruct.

12:00pm - 1:15 pm
Luncheon

1:15pm - 3:15pm
Transact Technologies
Transact Technologies' Russ Wige presents servicing and troubleshooting Transact brand, thermal ticket printers. These units are simple to understand and troubleshoot, once you know how they're put together.

3:15pm - 3:30pm
Afternoon Coffee Break

3:30pm - 5:30pm
JCM Bill Validators - This is arguably the best seminar of its kind in the gaming industry so we've saved the best for last. This presentation will be given by JCM's Jack Geller.

Quick & Simple Repairs # 42

By Pat Porath

Bally With "Lagging" Reels?

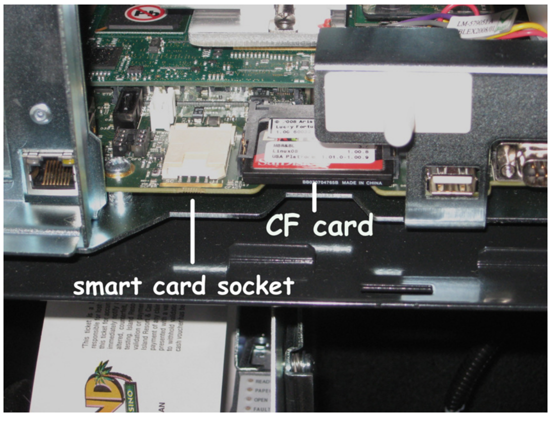
Have you ever seen a slot machine in which the reels "lagged?" Webster's definition of lag is 1. To fail to keep up: struggle. 2. To weaken gradually: slacken. I didn't believe the customer at first when he told me that the reels weren't working properly. This was a VIDEO slot, how could the reel NOT be working properly? He also stated that they spun really slowly. The customer asked me if I wanted to try it for myself. He gave me a $1.00 bill to try and as sure as the sun rises in the east, the reels were in fact slow and lagging when they spun. I didn't really believe it until I had seen it for myself. On every spin it would lag, not just sometimes. I admit I didn't have much of an idea where to start for a cure. Was RAM corrupt or was it a weak power supply? Maybe it was a bad CF OS card (Compact Flash Operating System).

Well, why not try a full game reboot. Not only turning OFF the "cabinet power" switch, but also turning OFF the "main power" switch. The cabinet switch only turns off some of the game power, leaving the main processor board powered up, where the main power switch completely turns the game off. After the game was rebooted and back in regular game play mode, I pressed the spin button to see what happened now. The reels spun as they were suppose to and worked perfectly. I played off the remaining $1.00 worth the credits to make sure it was ok and the game was fine.

Aristocrat Mark 7 Viridian "smart card error"

I was originally called to this game for a bill accepter that wasn't working. When I walked up, I noticed that it had a "smart card error" on the screen. Being that the Mark 7 is new to the market, I don't have very much experience with these yet, so I turned off the power to the game and reseated the main processor board. Once power was turned back on and it booted up, the bill accepter and smart card error disappeared. Once again a simple reboot cleared the error. Of course I will keep my ears open for any calls to the location of the game and when I walk through the gaming floor I will make sure to walk by it too see that the error is still clear.

Smart Card



Well, the next day when I came in the game was down again because of the "smart card" error. I was told to clean the contacts on the card with a pencil eraser and alcohol. This was done around 9:00 am but it failed again an hour and a half later with the same error. The card was swapped with a game nearby to see if the card itself was the problem. Sure enough later on in the day the failure came up again. We had a similar problem with a card once before, so a "smart card" and the game "CF card" was ordered (I was told both cards have to be replaced at the same time, not just one.). Once the cards are installed the game should boot up and run properly.

Both of the cards arrived shortly after they were ordered. They were installed and the game is operating great. When the "smart card" error appears on the screen, a reboot will TEMPORARILY clear the error unless the card gets really bad, then of course the error won't clear. For example: if a customer has credits on their game and it goes into the error, try rebooting the game to see if it will clear. If the error does in fact clear, then they could cash out their credits or continue to play. If the "smart card" error appears again after a game reboot, then more than likely a card will have to be ordered.

Upright Konami "TS communication" Error

On a Konami upright stepper game, a "TS" error is an abbreviation for a touch screen error. The first error that came up was a touch screen communication error, then after that the game came up with a "touch screen won't initialize" error. Almost everything was swapped with it. Of course the first thing that was swapped out was the monitor. The error stayed with the game, which told me that it may not have been the touch screen itself. Next, all of the boards were swapped (good old "swaptronics"). This included the I/O boards, the COM board, and the main processor board. With this completed, there still wasn't a change in the error. Two RAM clears were done also. When I was checking out the game software, in the touch screen section, "MicroTouch" was not highlighted, which meant to me that it was disabled. After the RAM clear I checked the touch screen software and now it was highlighted, but the error still was on the screen. The power supply was swapped out too. Still, no change in the error.

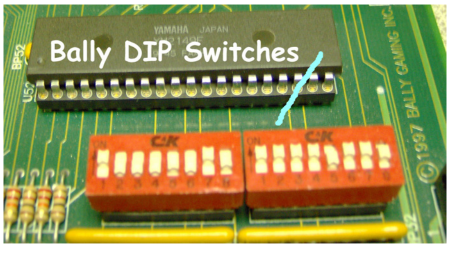
Pretty much everything was swapped out, what was left? I had to turn the game off and leave it for someone else to look at. The following day I saw that the game was back up and running so I asked what was done. A co-worker said they reseated the MicroTouch controller connector (which is located in the monitor chassis), put the monitor back in and it worked. I guess they had the "Midas Touch" with the "Microtouch" touch screen problem.

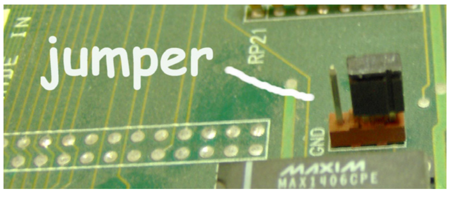
Bally 6000 Error Code 88

Those who have been working on games for some time know that on a Bally 6000 an error code 88 isn't a good thing. Specifically, the game is a Bally 6000 "Monte Carlo" with a bonus wheel up top. It is also a stand alone progressive. When I took a shot at getting the game back up and running, a RAM clear was my selection for the repair. Why a RAM clear? Because on a Bally game an error code 88 is a memory error. After the clear chips were inserted in sockets U28 and U43, it was time to apply power. Both the psuedo and test buttons need to be held in before the power switch is turned on. While holding the buttons in and turning on the switch, the display is SUPPOSED to show something on the order of CLL then CLC once the memory is clear. NEITHER ONE showed up, only the 88. To myself, I thought something was really, really messed up with this thing. The clear chips will not do anything? It was time to get serious. The main processor board had recently been replaced, so I checked it out. It was removed and all of the "board jumpers" and DIP switches were compared to a game next door because that game was up and running, working perfectly. Right away I could see why the clear chips did not work. A lot of the board "jumpers" and some of the DIPS were NOT the same. I took my time and double checked each of them to make sure everything was just right. Now with the clear chips back in, it was once again, time to apply power. This time the memory did clear and everything looked great. After the clear of course the game options needed to be compared. One cool thing about older Ballys is, in each game, from the factory, is a game option sheet. For example, option 10 is for the game denomination. With today's technology, just about everything is done with a touchscreen and the codes aren't seen much anymore. Now the game will display the error right on the screen (like "battery low") where in the older days of slot repair, when you received a call of a code 12, more than likely you needed to replace the battery on the main processor.

Anyway, back to the Monte Carlo. After the main processor board jumpers, the DIP switches and all of the game options were carefully compared to the game next door, you would think the game should be working awesome, right? Wrong. So wrong. Now the problem appears to be up top within the bonus device area (where you hit a bonus symbol on the payline, the ball up top rotates, and you get the amount of credits depending on where the ball lands). The game side looks great but the ball up top will not stop spinning. Around and around it went.

Since the problem appeared up top, I thought to check everything up there. I checked the connections and power LEDs. I looked to see if any cables had been pinched. The "Mikohn progressive" controller was rebooted. I reseated the EPROM on the controller board...on and on. I tried EVERYTHING I could think of and nothing worked. With shame in my heart and my head held down, I had to turn off the power switch and walk away. A co-worker asked me why the game was down and what I had done and what was done to it. I explained that I tried everything I could and didn't know what to try next. He looked at it and later on in the day he called me over to it. This was after the fact I went through the game once again, checked everything that I could think of and still nothing. We swapped the stepper motor driver board up top, no luck there. He tried another RAM clear, double checked game op-





tions, checked connections up top and even tried to simulate the same error on a game next to it. Still nothing. After that the main processor boards were swapped (With games that are a little bit older you can get away with it, but I DO NOT recommend swapping main processor boards with new games. A lot of them do not like it at all and you could have major problems.).

Once the board was installed in the other game, guess what? The error followed the board. Yes, the error followed the board. But, how could that be? It is a known good replacement board off of the "good parts" shelf. It even looked brand new. None of the connecters had any dust on them. The board's DIP switches were double or even triple checked, same as the "board jumpers." I didn't understand how in the world it was even possible that the problem was within the main processor board. How could that be? Come to find out that somewhere, somehow, in some way, maybe in another dimension, one DIP switch wasn't correct. The "concrete", "written in stone" CORRECT DIP SWITCH SETTINGS were found in a "Bally repair module." With all of the switches correct and everything else checked and re-checked, the board was once again put back in the game. Quickly after it was turned on, the ball FINALLY stopped spinning. I was getting to the point of taking the ball out and throwing it across the floor. It's almost hard to believe that one incorrect DIP switch setting could screw up a whole game. In this particular case, it sure did and it points to a hole in the logic of copying settings from another game: If the game features aren't identical, this error can lead you down a dark and dirty troubleshooting hole with no way out.

IGT "door open L" That Wouldn't Clear

We recently did a conversion on a bank of 16 games where they were changed from video poker games to video slots. The conversion was quite involved. Button legends, the main processor and even the backplane board had to be changed out. Once everything was installed and the game was "key chipped" there was one game that had a "door open L" that wouldn't clear. On these specific games there wasn't even logic door switch, so how could it show open? There was a jumper setting that wasn't correct on the main processor, therefore showing the door open. Once it was in the correct position, the game was fine.

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