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Slot Tech Magazine

Slot Machine Technology for the North American Gaming Industry

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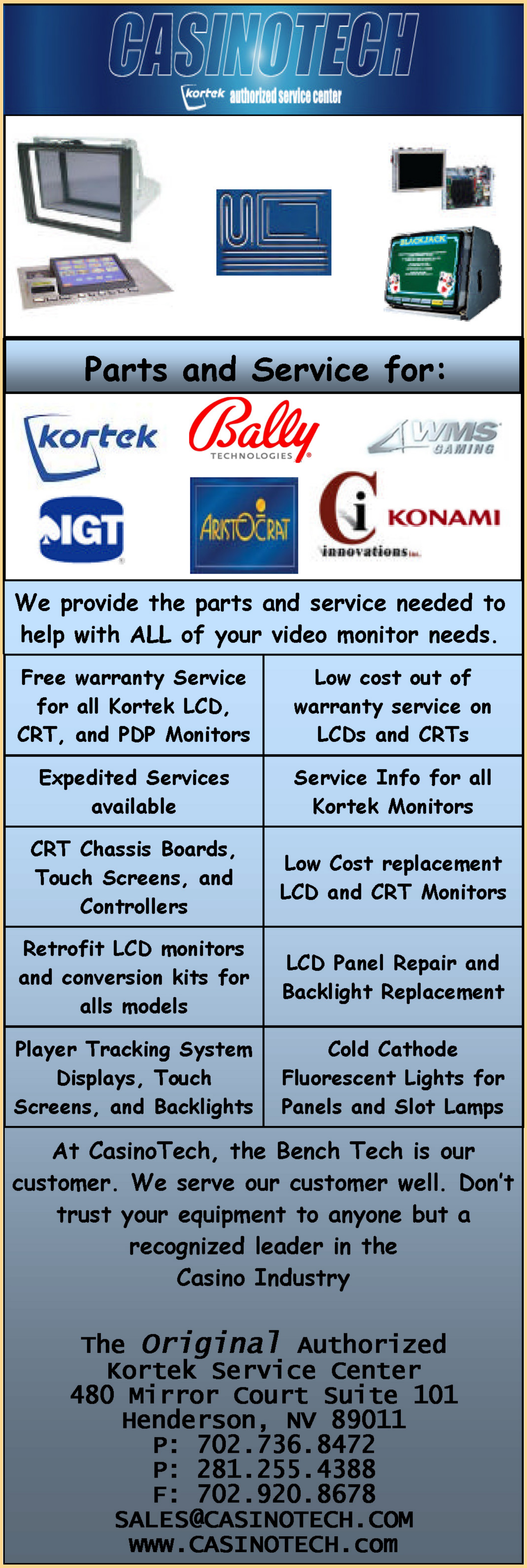
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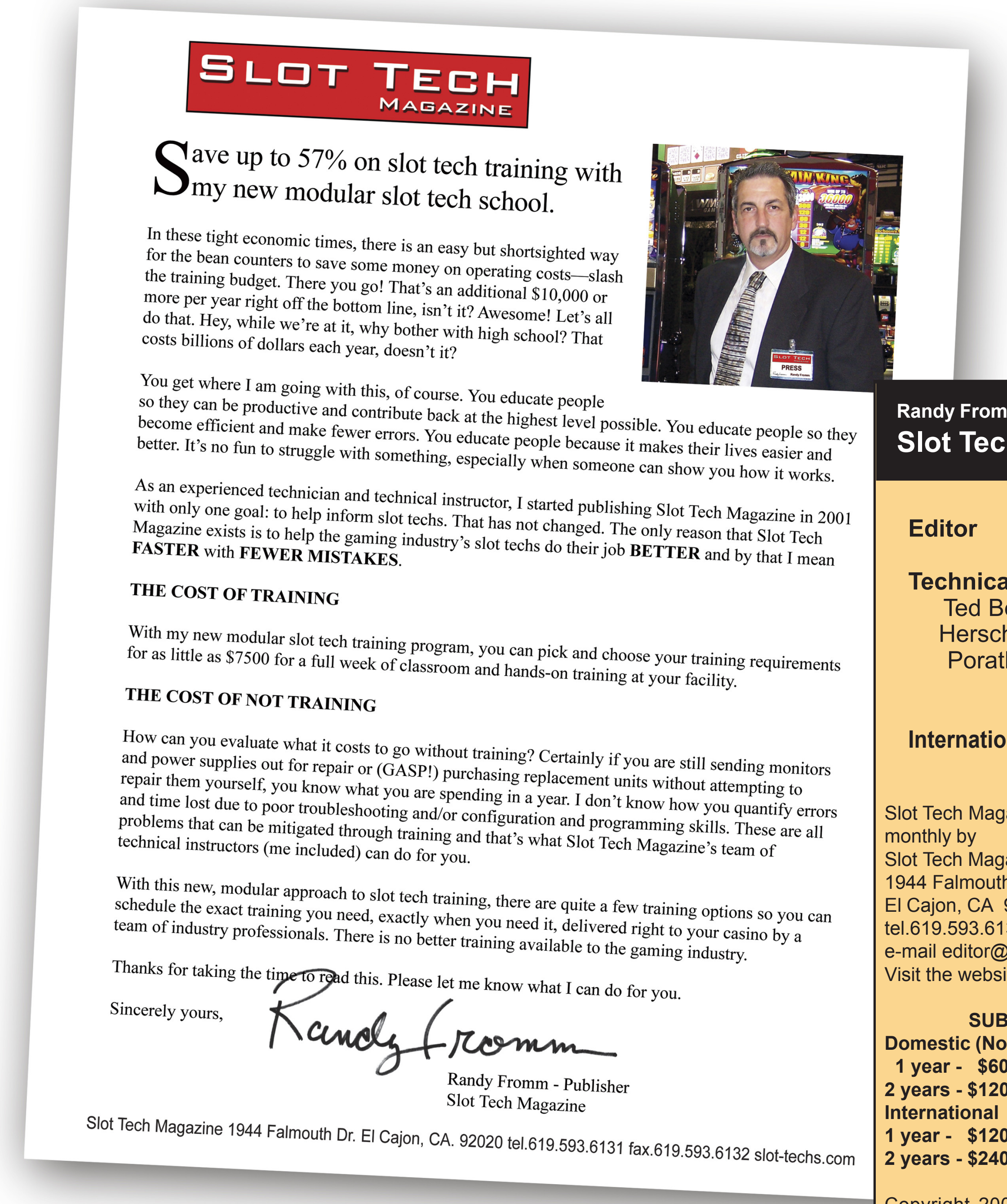

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MK5PFC Circuit Analysis - Part 3

When we began looking at the schematic diagram for the MK5PFC, did you ever think you would totally understand the entire thing? To be honest with you, I wasn't sure myself that I could figure it all out but here we are at the end with just a few circuits left to examine.

I will confess that I ended part two just a little prematurely. I hadn't just stop writing it prematurely, I had actually stopped examining the circuitry too soon as well because if I had spent just a few more minutes examining the circuit, I would have noticed diode D28 and included it in last month's discussion as it sort of ties up a loose end in our discussion of "Over Temperature Shutdown." That loose end is the mechanism of the shutdown itself. All we have done so far (in part 2) is detection. Now that we know what's going on, it's time to do something about it and that "something" is shutting down the power supply. This is easily accomplished because U14, the UCC38503 PWM Controller has an "Enable" input. Pin 4 has to be high (typically, it's around 8 volts) for the device to operate. All we have to do is to drag pin 4 low and the GT2 output at pin 10 turns off, turning off the entire primary circuit. Of course, the +24 VDC output goes down as well.

As covered in part 2, when an over-temperature condition occurs, U2, pin 13 goes low. The cathode of diode D28 is connected to this pin. The anode of D28 is connected to the Enable pin of U14. When U2, pin 13 goes low, it drags down the Enable pin and shuts down the power supply.

OVP

In this same area, we find the over-voltage protection circuit as well. Like the Over-Temperature control, it's U3. It's the one remaining section of U3, input pins 4 and 5 with the output at pin 2. Like an over-temperature condition, an over-voltage condition in a power supply needs to be dealt with swiftly and forcefully. Over-temp might destroy a power supply but a severe over-voltage condition has the potential of creating a lot of damage all over the system so we need to take care of it right away.

Pin 4, the inverting input of the comparator, is always looking at the +24 VDC output of the power supply. It's the green colored buss on the schematic diagram (if you don't have last month's schematic handy, you can download a copy from tinyurl.com/mk5pfc). It does it through a voltage divider made from resistors R113, R150 and R216. I really like the way these engineers think at SITEC because the total resistance of all three of these resistors is very close (less than 5% away) to 24K ohms. That makes it easy to see that you have one volt per ohm, making the voltage (when everything is normal) at pin 4, 2.2 volts. Compare that to the 2.5 volt reference and you can see that when all is well, the output of U3, pin 2 will be high and we will not be turning on the LED in U5. As you recall from the Over-Temperature Sensor discussion, as soon as we energize the LED in U5, the power supply is going to shut down and you can easily see now how that's going to happen. When the power supply output rises above +28 VDC, the voltage at pin 4 rises above 2.5 volts, making the "-" input higher in voltage than the reference at the "+" input and forcing the output at pin 2 to go to ground. Of course, this completes the ground connection for the LED in U5, turning it on and subse-

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quently (and immediately) turning off the power supply as explained earlier in the Over-Temperature Sensor discussion.

Recap: Bad things such as over-temperature or over voltage will turn on U5.

Let's go back to relay K1 and recall that when bad things happen to the power supply and energize U5, K1 drops out and no longer shorts out the 18 ohms worth of resistance that is in series with the mains at the AC input. Let's see how the power supply is going to react to this series resistance.

Naturally, putting 18 ohms in series is going to have a noticeable effect on things. Specifically, the unregulated primary voltage is going to drop. This is where having the colored busses really comes in handy because if you follow the sort of pink colored primary DC buss all the way to the left, you'll see a voltage divider made of seven resistors, R199, R214, R213, R121, R122, R154 and R156. Our divided voltage is applied to pin 6, the inverting input of one of the four devices inside integrated circuit U2, an LM339.

You can see from the fact that these guys are all .5% resistors that this is something important. This is where we keep an eye on the primary DC voltage. This is another comparator circuit. Our reference voltage is at pin 7, connected to the 2.5 volt reference buss through precisely 1000 ohms (again, .5% precision resistors are used).

It is worthy to note that the 12 volt power supply for the LM339 U2 and the reference voltage generated by U8, the TL431 comes from U13, the three-terminal regulator we discussed in part 1. Because the 12 volt output of this regulator is so low in comparison to the +360 VDC or so that is its input (when the mains input is 240 VAC) the output of the regulator will remain perfectly stable, regardless of the fact that we may have dropped the primary DC voltage somewhat with the inclusion of the 18 ohms of series resistance or even in the case of a serious problem with the mains input. This +12 volt supply will remain up and perfect for quite some time, even as the world collapses around it as the input only needs to be a few volts higher than the output in order to function perfectly.

Normally (when everything is operating properly) the voltage at pin 6 is higher than pin 7, activating the output and dragging pin 1 down to ground. Notice that it is the "hot ground" on the primary side since that's what we're looking at here. This turns on the LED half of opto-isolator U6.

When we throw the 18 ohms of resistance in series with AC input, the unregulated primary voltage drops. The voltage at U2, pin 6 drops below the reference voltage and the output at pin 1 will swing high, leaving the LED without a return path, its cathode swinging in the electronic breeze without a path to ground. Of course, this turns off the LED.

Resistor R160 straps the output voltage back into the non-inverting input, assuring that the output at pin 1 remains latched "off" and that the circuit doesn't reassert itself. The specific circumstances of this reassertion do not warrant discussion in this article.

So to recap, if the primary voltage is good, U6 LED is on. If the primary voltage begins to drop (whether caused by the 18 ohms of series resistance OR by an actual drop in primary voltage caused by a significant drop in the mains voltage) U6 LED is off.

If we're driving the LED half of an opto-isolator we must be getting ready to talk to the outside world. We are, but in a surprise move, all of this primary voltage detection that we just performed has absolutely nothing to do with the actual power supply. That is to say, it has nothing at all to do with the generation of the +24 VDC output of the power supply. It is a detection circuit that talks to the

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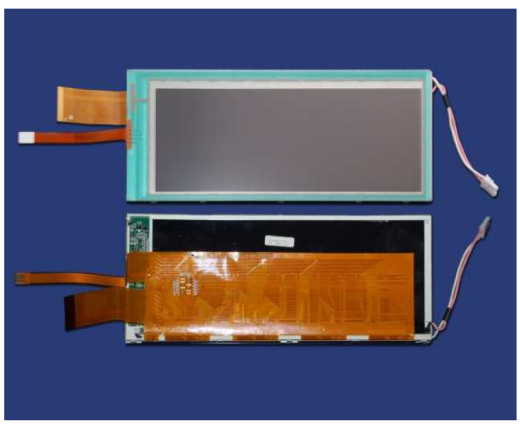

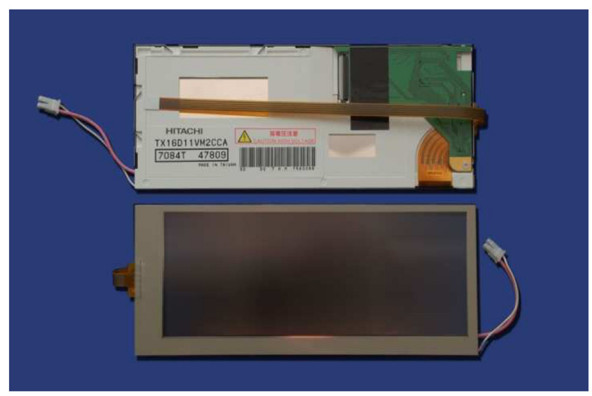

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slot machine itself. It examines the condition of the primary DC voltage (from which it infers the condition of the mains-when we add the series resistance, we are actually "tricking" the power supply into thinking that the mains voltage is dropping) and signals the CPU in the slot machine through the status of the "Power Fail" signal. You can see it on the schematic diagram at pin 9 of connector X9. Follow it back and you'll see it's connected to the drain of Q2 so obviously, when Q2 turns on, the PFAIL signal will go low.

We'll back up and look at the entire circuit in just a moment but I want to pause and reinforce this concept to those of you who have been wondering just how it is possible that you can have a power supply that works perfectly on the workbench, producing a perfect +24 volt output under a massive test load but fails to operate in a slot machine. This circuit is totally separate from the +24 VDC power supply. The circuit lives in this box and on this PCB because this is the only place where the slot machine actually physically touches the mains and, as you have seen and as you will continue to see in this article, we need to watch the mains so that in case of power failure, we can tell the slot machine to store data and perform an orderly shutdown. This is one of the ways we do it.

This circuit really has nothing at all to do with generating the +24 VDC output. It just lives in the same box, looking at the primary DC voltage and telling the CPU what is happening through the "Power Fail" output signal.

Let's go back to opto-isolator U6. This time, let's look at the transistor half. We are now on the isolated, secondary side of course, where everything in the slot machine is all grounded together.

This is an interesting design in that you see the transistor in the source path rather than simply acting as a ground switch. If the transistor in U6 is on, the +24 VDC output buss is connected through the transistor to pin 6, the inverting input of U1. A 6.8 volt Zener diode pegs the voltage at no higher than 6.8 volts. I have an engineering issue with this circuit as there is no resistive current limiting here other than semiconductor junctions. I am going to run this by the engineers at SETEC for comment.

This circuit compares the voltage at pin 6 to the reference voltage at pin 7, the non-inverting input. As long as the power is good, pin 6 will be higher than pin 7 and the comparator will be active, its output voltage dragged to ground at pin 1. When the power fails, U6 turns off and the voltage at the non-inverting input (the reference voltage) will exceed the voltage at pin 6. The comparator "turns off" and pin 1 is pulled up to the +24 volt buss by R187.

Of course, you can see that what we are really doing here is controlling the gate of MOSFET Q9, which is connected directly to the comparator output at pin 1. When everything is normal, pin 1 is low and Q9 is off. Upon power failure, Q9 turns on.

Now, it's on to the next stage. It's also U1, this time pins 4 and 5 are the inputs and pin 2 is the output. Our reference voltage is connected to the "+" input while the voltage at the "-" input is determined by Q9. If Q9 is off (normal operation) the voltage at the inverting input will be higher than the reference and the comparator output at pin 2 will be low. Upon power failure (when Q9 is turned on) the voltage at the inverting input drops and the comparator turns off, allowing the voltage at pin 2 to rise, pulled up by R179. This, of course, gates MOSFET Q2 and when Q2 turns on, it generates the "Power Fail" signal, more correctly referred to as "Power Fail Not" as it is an "active low" output. You'll notice that the signal is labeled PF with a bar over the top. The bar on top indicates an active low signal. Oddly enough, the same signal is labeled

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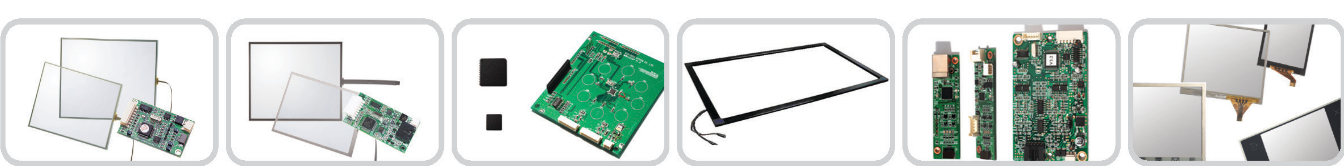

“PFAIL” at the connector, without the bar over the top. I think that’s just an oversight.

That’s it. That is the whole point of that circuit. You can see that it has nothing to do with the creation of the +24 VDC output nor does it have to ability to perform any sort of shut-down of the power supply on its own. It can only talk to the CPU. It’s a sort of tattletale circuit, a Rat Fink, a Stool Pigeon, a squealer (I gotta stop watching old prison movies).

Output Monitor

While we’re in this area, let’s take a look at another circuit that is used to monitor something, this time the +24 VDC output itself. We have already seen how the power supply will respond (immediately) to an over-voltage condition by shutting down the power supply before damage can occur. On the other hand, in the case of a loss of the +24 VDC output, we don’t have to worry about damage and we don’t have to shut down the power supply. It’s already going down! However, if the +24 VDC output isn’t up and running (or, more specifically, if it is in the process of failing during otherwise normal operation) it would be nice to let the CPU know about it so it can do some housekeeping.

The output monitor uses the remaining two sections of U1, the LM339 Quad Comparator. At first glance, it may look like this is some sort of circuit without an input. You can see that the non-inverting input at pin 9 is connected to the reference buss but what’s up with the “-“ input at pin 8? It looks like it’s just hooked up to the +24 VDC buss through some more of those .5% precision resistors, R173 and R208 (both 1.8 k in series for a total of 3600 ohms) and R181 and R209, both 2k ohms in parallel for a total of 1000 ohms. The use of precision resistors tells us we’re monitoring something important here and in this case, we’re looking at the +24 VDC buss itself, the same buss that is powering U1. That’s our “input!”

Of course, first semester electronics students learn all about the voltage divider and we have sure seen a lot of them in this power supply. This is another classic example of why we learn about this stuff in school. The problem is that in school, we aren’t shown WHY or WHERE we use voltage dividers. This is a beautiful (and easy to understand) example of voltage division using resistors. When the output voltage is +24 VDC, the voltage at pin 8 will be 5.2 volts. This is higher than the reference voltage at pin 9 and so the comparator is active; the output at pin 14 is zero volts. You can see that this output is connected to the gate of MOSFET Q8. As long as the output voltage of the power supply is greater than 22.5 VDC, Q8 remains off. However, if the output voltage drops below 22.5 VDC, the reference voltage at the “+” input will be the higher than the voltage at the “-“ input and the comparator turns off. Resistor R189 pulls up the gate and Q8 turns on.

Recap: +24 VDC output normal, Q8 off. Output less than +22.5 VDC, Q8 on.

When Q8 turns on, it completes the ground connection for resistor R195. What this is really doing is dragging down pin 10 (as part of a voltage divider-again!), the inverting input of the following comparator stage. It’s the normal deal as we’ve seen again and again in this design: pin 11 (the + input) is tied to a reference voltage and the condition of the – input determines the output. When the voltage at pin 10 drops below the reference voltage at the + input, the output at pin 13 swings high and gates the following MOSFET, in this case Q3.

This creates our “Output Fail” signal. Like the Power Fail signal, it’s an “active low” signal that speaks directly to the CPU through a dedicated connection at X9, pin 2. If the output voltage drops below 22.5 VDC, this output goes low. The CPU then decides what

to do next. Again, this signal actually has nothing to do with the generation of the +24 VDC directly nor does it have any sort of protection or shut-down facilities of its own. If there is any shutting-down to do, these two circuits (Power Fail and Output Fail) don't do it directly. They can only tell the CPU what is happening.

Remember the Mains!

Of all the things that can go bad while a machine is in operation, loss of AC power is by far the most common occurrence. From the machine's point of view, this happens a lot. It happened a bunch of times before the machine ever made it to the slot floor! Every time the power switch is turned off or the machine is unplugged or disconnected from the mains (accidentally or otherwise) the machine (obviously) loses power but as we have seen, the entire system doesn't actually lose power immediately. Because of the energy stored in the electrolytic capacitors, we have a little bit of time to put things in order before we lose power completely.

Our goal here is to detect when we have lost the AC input power right away, before the +24 VDC output of the power supply fails. However, we don't want to jump the gun and start shutting things down too soon. We don't want the loss of a single cycle of AC (or even two or three cycles) to trigger a shutdown. A momentary loss of AC shouldn't affect the machine if the +24 VDC output remains perfect. On the other hand, you don't want to delay in starting the shutdown procedure if the problem is a genuine loss of AC power. By the time the output of the power supply really is affected, it may be too late to do anything about all the data in the CPU if we haven't completed housekeeping before the power supply craps out.

What we need then is a compromise and that's what the MK5PFC does. It looks at the AC input and after around a half-dozen missing cycles decides that that there is a real and persistent loss of AC power and it does something about it.

And what it does is pretty darned interesting and now, since you already know all about how all the other stuff in the power supply operates, we can see how the AC input detection works and what it does to the power supply.

Let's start with the detection circuit. We want to know when we have lost AC power so we use a single diode (D3, a common 1N4007) to look at the positive half cycle of the waveform. We'll get 50 or 60 pulses a second here. The voltage of this pulse is divided down to a more reasonable level and applied to the inverting input of U2 at pin 8. The trick here is that we want to be able to miss one or two or even a few pulses without triggering the CPU to begin a machine shutdown. This is accomplished by hanging an electrolytic capacitor (C67-22uf) from pin 8 to ground. The larger the value of the capacitor, the longer the time constant and so this value was chosen to allow the system to remain operational with the loss of a few cycles but trigger the "Power Fail" signal when there is a real loss of AC power as the voltage on C67 (and pin 8) will quickly bleed off through R212 and the input structure of U2 when the AC goes missing. As the voltage on pin 8 drops below the reference on pin 9, the output at pin 14 goes high, gating MOSFET Q11.

At this point, a couple of things are going to happen more or less simultaneously. One is that the unit will generate the "Power Fail" signal that tells the CPU to store data and shut down properly. The other is that the power supply itself will shut down, killing the +24 VDC output.

Let's look at generating the "Power Fail" signal first. This is easy because we've already seen how a drop in the primary DC voltage will trigger the "Power Fail" signal. We just have to see

how the two circuits are connected and the way they're connected is by diode D26. The anode is connected to the "-" input at U2, pin 6. This is the pin that is also watching the primary DC voltage. The cathode of D26 is connected to the drain of MOSFET Q11. When Q11 is energized (due to a loss of a half-dozen cycles of AC power) the cathode of D26 is essentially grounded, dragging the inverting input at U2 pin 6 down in voltage. The result is precisely the same as it is when the primary DC voltage drops, eventually resulting in the active low "Power Fail" signal being generated.

At the same time, when AC power is lost and Q11 has energized, it will drag down the voltage at U2 pin 4, the inverting input. This will turn off the comparator, allowing Q12 to turn on (it gets its gate voltage from R232 and R233).

Once Q12 is turned on, we're really going to kill some things. Firstly, take a look at diode D27. The cathode is connected to the drain of Q12 and anode is connected to our old friend, the Enable input of U14, the UCC38503 PWM controller IC. When Q12 is turned on, we're going to kill the +24 VDC power supply immediately. We are going to turn off all primary activity and that's a good thing because we don't want to waste any of our precious stored energy messing around. By grounding the Enable input through Q12, we turn off all PWM activity and now rely on the charge stored in the secondary electrolytic filter capacitors.

Secondly, you can see through the connection of diode D39 between the exact same drain of Q12 and the gate of Q4 that when Q12 turns on due to a loss of AC power, it will also drop out relay K1. You can go right back to the very beginning of this discussion if you need to refresh yourself on all that that entails.

The Stuff That Fails

So, that's how the unit works. It's hard not to call it a complex system full of circuits that create, control, regulate, signal and shut down but broken up into its individual functions (and with familiarity and an annotated schematic diagram) it becomes manageable. This is not a cheap, disposable power supply but they can fail from years of 24/7 operation inside a hot slot machine. Somebody has to repair these things and now that you know all about the unit, that someone can be you.

On the other hand, many technicians (me included) are just as happy to have a list of the stuff that fails as we are to have a detailed and exact knowledge of how the system operates. As a technician, my job is to fix stuff as quickly and accurately as possible. My job is not to prove to my co-workers how smart I am. If someone can tell me what to replace, I am happy to have the advice and if I have it, I am happy to share it.

To that end, I asked the folks at Aristocrat and SETEC to name the top dozen faults for MK5PFC. You can now totally forget everything you just learned about this remarkable power supply.

Low output voltage -> C89 leaky
Unit unstable -> C52 failed
No power up -> C66 leaky
T1 noisy
No power up -> Q1 failed
No power up -> U7 failed
No power up -> R127 open circuit
R77, R202 wire wound
U13 Voltage Regulator
U14 Surface Mount IC
D1 Bridge Rectifier
D11, D12, D43, D50 Diodes
Pin pushed back in X3
S1
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Because what you don't know CAN hurt you.

Solving Machine Problems

By Kevin Noble

Atronic Cashline "Main Door Open"

This newly theme converted game was just placed in service and did not even last the night until it was placed in our laps first thing in the morning. Upon receiving our keys it was mentioned this Atronic Cashline was down because there was a Main Door Open code on the monitor that passed on to us from the afternoon shift. After opening the game and checking through the entries in the MEAL book, we noticed that the main Cherry switch and the belly glass door optic had been replaced but the exiting error code was still there.

First thing that I did was to check the wiring on the Cherry switch to rule out a miss-pinned or not connected wire on the switch. I then checked the Cherry switch to make sure it was working properly. I jumped the wires to verify the Mikohn door alarms incremented correctly. I checked the transformer that powers the small board that is connected to the hard meter board, checked the safety plug to make sure the breaker did not pop, and switched outlets with the fiber board transformer just to narrow down what could cause the problem but the problem still existed.

"T" and I started doing some part swapping with the game beside it to try to isolate what was causing the problem. We started with the small board that is connected to the hard meter board, then the hard meter board assembly. Next, I stretched and plugged the Belly glass harness in the machine beside it. Still the main door open code existed. So we decided to stretch the Belly glass cable from the known good machine into mine and the main door code went away. We next grabbed a brand new Belly door optic harness from the shop in my game and the game now is working fine. I broke another of my unwritten rules when I trusted what somebody else had done without starting from scratch. It has bitten me in the behind a million times when I have trusted what was written in the MEAL book and started where they have left off.

IGT I-Game Video Touch Screen Communication error + Printer Communication Error

After closing the main door (and sometimes on its own) the touch screen and printer communication error would appear on the monitor. At the beginning, the error was cleared by just opening and closing the main door. But this started to be an every day occurrence and especially after the soft drop was completed in the morning. Reggie states the printer and monitor had been changed on this game but the problem remained. Taking the initiative to repair this game, Gary Smith noticed that when the door was closed, if you moved the BV bezel the error would go away. So he thought the BV bezel was placing pressure on the BV light board causing it to short out and caused the errors mentioned above. The BV light board was removed and the problem

stopped. Gary and Reg mounted a shield behind the BV light board and reported that the problem went away. But within a couple of hours the problem returned. The BV was removed to remove the modification when it was noticed the BV harness had two wires stuck on a small tab on the BV housing that were bare. This was caused by the BV transport being reset all the time and when the main door was shut it placed pressure on the transport and caused the error. This harness was then replaced and the problem went away.

IGT I-Game Video
Main Door Codes

We received a call from surveillance about a game that had the alarms screen flickering main door open / main door closed. We noticed that the game was secure and a patron was playing the game so we knew we were dealing with a Mikohn communication problem. Checking back every few minutes to see if the game was available, we were able to jump on the game to troubleshoot what was causing the problem. With our players card inserted, we noticed the Mikohn doors were toggling “G” for door closed, then “g” for door open constantly. Our next step was to reboot the SMIB to see if that would repair the problem but when we opened the top glass, we noticed the printer metal cover was off the printer and was lying on the SMIB board. Once removed, the door codes stopped toggling and the error messages went away. Good thing it did not take out the SMIB and others on that DCU.

IGT I-Game Video
Printer and Touchscreen Error

After the Soft Count crew completed their drops on a bank of IGT I-Games,

we noticed the error message "BV communication error" error on the monitor. We checked the wiring in behind the BV transport to see if there was any physical problem with the wiring. At first glance, we could not find anything wrong so we started swapping parts with the game beside it. After assembling both games we found the harness that runs in between the cash box assembly and the housing was bad. The small 3-pin power plug had a bad connection. We reconnected the two harnesses and the red LED on the BV transport came back on. A couple of days later the same problem occurred, this time straight to the problem. The connection just was not making good contact so we decide to eliminate the connector all together and hardwire them to get the machine in service. After receiving and replacing the BV cash box harness and assembling the cashbox unit, a new message "Printer & Touch-screen error" appeared on the monitor. One of the Techs tried replacing the printer but the message would not go away.

Next on the list was to unplug the harness we just placed in the game to see what would happen. The error message went away. Securing another Security escort, lock and cart, we preceded to disassemble the BV unit where we found a broken wire on the harness. Was it there before or after we assembled the BV cashbox unit? That was the question for the day. Nobody knows. Completing the reassembly of the cashbox unit, we placed the game in service, the BV came online and the machine was ready for patron play.

IGT S2000
Sound SIMM Memory Error

Known for our thunderstorms and power outages, we had a weird power failure from a quick "Now you see me, now you don't" thunderstorm storm. The power dimmed to where it almost went out and returned back to normal in the wink of an eye. What was left was a handful of games that needed to be reset except this one IGT S2000 that had a system error that could not be cleared. The system error was reset until the "Sound SIMM Memory" error came about that was un-clearable. A continued round of events of opening/closing of the door, pushing the diagnostic button for two to three seconds, just to end up where I left off, the dreaded "System Error." I called my buddy Wendell Rubio from IGT and he let me know a secret when using the SNDF DSS0042 sound card. He asked me to remove the card to see it would then boot up into game mode, which it did. He next told me to remove one out of the Reel Touch game and place it in the IGT S2000 that was bad. The warehouse had them installed in the SNDF card because it was in our slot files when submitting projects to the AGCO. He explained that the Reel Touch games do not use the sound board and they can be removed from the games. I removed the SNDF board, placed it in the bad game and the game was ready to be placed in service. I just ordered another sound board and placed it back in the reel touch game that I missing one so I could have a spare in case I needed one.

Bally Alpha Reel
No Power to the CPU

When you turned the little power switch on the CPU, the game tried to boot up and it would power itself back down. The LED on the CPU would flicker just for a second and disappear. It seemed like the CPU was overloaded. We knew it was a CPU problem because the day before the Techs placed a CPU from the game beside it and it powered it. The stench of something was burning after removing the CPU from the housing filled the air and you knew something was definitely wrong. We could eliminate everything from the game except the CPU itself. Just to be sure we swapped the CPUs power supply with one it the shop and the problem still existed. So we placed the spare CPU with no

EPROMS in it, powered it up and all things were normal. We swapped all the parts including the locks, RAM cleared the game, set the options, tested the progressive and placed the game back in service after AGCO's final inspection.

The TPE_RPT Again

Since my last TPE_RPT report encounter we moved the games that were causing the "VGM responding / not responding" every second came back on the same theme game, but this time the closest Bally Gamemaker was eight games down the row. This was a different machine causing the exact same problem, but this time we could not blame the Bally Gamemakers UGM. On this bank earlier the first Gamemaker on the bank had issues regarding printing a ticket dated three days later with the same information (validation number, sequence number, date, and time) but different amounts. The latest ticket printed said it was already cashed in at the Cage. I figured this time the same problem occurred causing this IGT video slant top on the end of the bank to react just like the problem I had seen a couple of months ago. But that was not the case. I started swapping parts with this machine, ran to the shop, pulled up the report to see if I cleared the errors. Next I started leaving parts out of the loop. I started with removing the CPU board and powering off the machine. I again ran downstairs to the shop, pulled up the report and noticed that the errors stopped. The last error was at 15:27:37. I ran back out to the floor, and powered the game on, but without the CPU plugged in. I ran back to the shop, pulled up the report again, and the last error message was 15:27:37. So far; so good. The true test was about to begin, replacing the CPU board back in the game. I debated on whether to place the CPU in the game with or without the power. I decided to do it without power. What was one more trip to the gaming floor anyways? No new errors were logged on the computer with the CPU in the game, until I powered back up the game. By the time I got back to the shop I had

25 error messages in a span of two minutes and 30 seconds. Just enough time to close the machine door, get to the shop, and bring up the report. The next step was to RAM clear the game or replace the CPU board. I replaced the CPU board, completed the clear and set procedures and placed the machine out of order. I went to the shop and monitored the TPE_RPT for a day and found no error messages and the fact that I was not getting e-mails everyday stating this game is not working properly. Sorry Jasmina, I will not miss those e-mails stating that the game has bad sequence errors.

- Kevin Noble
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Monitor Approach

By James Borg

The last thing you want to do when you're not feeling up to it is to tackle a monitor that's gone on the blink. What do you do? How do you go about it? Where do you actually start from? Do you panic? Do you push the red-button? An alternative to pushing panic buttons is to use the three Cs, that is keeping Cool, Calm and Collected and use your senses. Well, at least four of them, namely sight, smell, touch and common. Incidentally, the common sense is the least common of all the senses but it can get you out of a lot of hassle and time wastage and you look good with the guys upstairs knowing what you're doing is in an orderly and efficient manner.

Before you make an official declaration to the whole world that the monitor is dead or dying, it would be wise to see if the slot machine itself is still operational. A slot machine that isn't working properly might have ceased to pump out the video signal to the monitor giving the impression that the monitor is faulty. Generally, its lights and sounds would be still working, and so would the bill validator. If those are showing signs of normal day-to-day operation, then the slot machine most probably is fine and the monitor itself could really need some attention after all.

An approach to fault finding a monitor isn't the easiest thing in the world but with time and practice, you tend to develop the skill. Having said that, it's not the first time that I was taken for a

ride myself, and that's after years of tackling these babies. The end result, providing it's repaired, would be a great sense of satisfaction. This is one of the few things left that keep me going in this line of work, the sense of satisfaction. It makes you feel like you want to walk on clouds and your self-esteem shoots up and hits the stars. That's the way it affects me anyway. It could affect different people in different ways (some not being effected at all) but each to their own.

Editor's Note: I totally agree, James. I feel very happy when I repair something.

Right, where do you start from when a monitor goes down? I'm referring to the normal CRT type of screens and not the TFT or Plasma ones here. There are so many different ways it can go down. An initial glance at the screen tells quite a bit. Is it completely black? Is there a raster? Is the picture faint? Is there any contrast or brightness control? Is the picture distorted? Is there half a picture? Is it big or small? Has it shifted to either side or up and down? Is it displaying different colours? Has it made a noise? Does it smell bad? Can you hear static building up? Can you hear the degaussing relay clicking? Can you hear the degaussing coil itself being energized? Do you hear a "tick – tick – tick – tick" in the background every second or so? Is the picture moving from side to side making you sea-sick as you look at it? Is the area where the monitor is located full of smoke and people spluttering and reaching for their gas masks?

Anything at this point which is or isn't normal can help you locate the section where the problem is located or at least as close as can be without getting your tools out and doing some tests. A schematic diagram is always appreciated to assist in the location of the problem, however, this is not always available and that's where the going might get tough. It's not a question of "the tough get going," it's more a question of you ending up with a splitting headache, sore eyes and upset since your monitor would still be faulty after all your hard work and best efforts.

A quick and very rough and crude diagnostic aid is to hit it. Yes! You heard right. Hit it! I don't mean to smack it with a sledge hammer but to thump it slightly and see what happens. If it's a dry joint or connector trouble, chances are that you'll see something shift on the screen, even if only for a fraction of a second, enough to let you conclude that it's a dry joint or connector which is the culprit. This type of fault isn't usually difficult to trace but I have had instances of not actually spotting the joint and having to re-solder individual areas all over again in the hope of locating it without even realizing it. This can be quite time consuming and tedious. I suggest a well lit working top and if you're lucky, one of those round lights with a great big magnifying glass in the middle. The naked eye isn't always the best solution to spotting this type of problem on a board, more so if during the process, you apply a spot more of solder than you should and end up shorting two points without realizing it. The result of this might be a catastrophe so do it slowly and surely and go easy on the solder, especially watching out for blobs draining off the end of your soldering iron and finishing off somewhere where they shouldn't.

A little trick to locate a small percentage of faulty contacts on a printed circuit board is to turn the lights out totally and end up in a pitch black surrounding. Have a little flash light handy so you can quickly locate equipment switches and such. Leaving your equipment turned on and while hitting or bending the board or whatever you deem necessary to locate the fault, watch for small sparks on the PCB. This usually works better where the area concerned has higher voltages and currents but a bad joint on a low voltage area will still provide you with a spark, although of a smaller magnitude.

Another quick test is to switch it off or on and listen for the static build up on

the tube. You'll know as you'll hear it and the hairs on your arms usually stand on end. If there's static then you can rest assured that your high tension (EHT) is there so that's not your problem. As a kick I usually run my hand on the actual screen and "absorb" the static. Be careful when doing this not to touch an earthed point immediately after as since you're all charged up with static, being discharged quickly can make you jump, and high! Not a very pleasant experience either. I remember not so long ago, Marco, one of my mates who does regular maintenance work on our slots, was standing right next to me to assist me when I performed this trick of absorbing the static. I forgot to tell him not to touch me as he was leaning on the metal frame of a slot machine. Incidentally, he did touch me and we both jumped a couple of inches into the air. He was literally shocked and I wasn't amused. All I could see was white for the next few moments and it was as if somebody just kicked me into the air. I explained to Marco what happened, giving the example of Christmas lights being in series etc. He was quite happy with the explanation but wasn't happy with the side effects of touching me. He didn't dare touch me while working on a monitor after that. No wonder why not.

Is it completely black? Is it as dead as a door-nail? Nothing at all was heard when turned on and off? If this is the case, chances are that the power supply is shot. It's not necessarily the case as it might just not be working properly due to a short circuit or an overload on the secondary circuits which are loading the switched mode power supply hence not enough juice is reaching the circuits to operate properly and so no picture is visible. Just for the sake of mentioning it, if I was you I'd also check that the mains is actually reaching the monitor. Some slot machines supply their monitor through **bus bars** that are individually fused for safety reasons. A quick check of the fuse and cabling feeding the monitor won't go amiss and making sure that the plug to the monitor is actually firmly connected. I've come across something like that before. One has to assume that the obvious isn't always so obvious. It's no big deal pulling out the monitor and taking it to the workshop and finding that nothing at all is wrong with it, problem is that it's usually quite heavy and bulky and if you're dressed nicely and well groomed, then you'll look like a mess after the monitor's put back in place, especially since it really didn't have to come out at all in the first place, which makes you feel twice as awful.

If the power supply section's shot, sometimes the mains glass fuse will be black, and sometimes even the glass itself will be gone, leaving the shiny metal ends stuck in the fuse holder with nothing in between them. The rated fuse here is usually that of 3.15 Amps and is 20 mm in length.

With the fuse in such a state, not many things could have resulted to its

total destruction. It can be the posistor (this was discussed in the article on Degaussing). It can be one of the four diodes making up the bridge rectifier has gone short. If the bridge rectifier is made up of separate diodes, manufacturers usually enjoy using the 1N4007. This is basically a 1A 1000V rated standard rectifier. From experience, if one is shorted, it's best to replace the lot of them. It won't take long anyway and it will save you having to do the same again within a short while since the other three would have suffered a jolt that they didn't appreciate, even though at the time they give the impression that they are still perfect. It can also be the chopper transistor on the switched mode power supply that has shorted out. In the case of a normal transistor, the collector would short to the emitter and in the case of an MOSFET, the drain would short to the source. In some extreme cases, the main reservoir capacitor could have developed a punctured dielectric. In electrolytic capacitors, this is a thin insulating coating between the plates. Once this dielectric is punctured, the capacitor stops being a capacitor and becomes a nice link, which can and will easily short out the rectified mains just after the bridge, blowing up the fuse easily. If during the course of checks with your multi-meter, nothing seems obvious as to why the fuse is blowing, a good guess would be to replace this capacitor. You can spot it immediately as it sticks out like a sore thumb and is located next to the fuse area. Typical values of the reservoir would be in the order of 330uF / 400v DC. You can also find two capacitors of 220uF / 200v DC. Just to be on the safe side, just check them both out.

A very weird fault I once came across was the mains fuse blowing for no apparent reason. I checked the bridge, the posistor, the reservoir capacitor, the chopper and the whole lot but nothing was wrong. Every time I put a new fuse in, BOOOM!!! And go back to the drawing board. I was really so confused with this one that I started doing illogical things, like actually pulling out the chopper transistor… BOOOM!!! Pulling out the reservoir capacitor…BOOOM!!! Pulling out the posistor, the degaussing coil, the filter capacitors, and the filter coil. There was only the kitchen sink left to pull out after that…result…BOOOM!!! This was starting to hurt my pride quite substantially as nothing was making sense at all, apart from the fact that my supply of fuses was running out quite fast. Also, the constant BOOOMs were hurting my ear drums. I was well and truly lost, doubting my skills, doubting my abilities, doubting about everything. The black cloud hovering over my head got bigger and darker but I had to find out as the suspense was killing me. The only thing that I didn't replace was the chopper transformer. Surely it can't have been it as I had never EVER found one that was faulty but having said that, there's usually always a first time for everything. With that thought in mind, I started to unsolder the pins off the transformer till it fell out. Putting a new fuse in the holder didn't have the resulting BOOOM as before. Conclusions? Was it really the transformer after all? Well, the news is that the transformer was perfect. The culprit was glue. The manufacturers had used glue to help anchor the transformer in place. Being a heavy component, this could come away from the solder connections if the monitor was handled pretty violently. No mounting screws could be used as there were no holes in it to pass them from, so as an alternative, glue was used on the pins. It's a good idea of course, but not in this case. A blob of the stuff that was between the rectified mains and an earthed point had become conductive over time. Probably heat from the surrounding components acted as a catalyst in its process of it not remaining an insulator. Originally, the glue is of a light coloured appearance, but after a time of being exposed to the elements, this sort of changes colour to brown, dark brown I've found as being the worst. In this state it's conductive which in my case caused the BOOOM every time I turned on the juice to it.

If you're having a really bad day, the chopper transistor would have been shot blowing the SMPSU to pieces. The ideal scenario would be that all the silicon in the chopper transistor becoming totally fused sending high voltages to low voltage circuits. You'd know soon enough once you have a look at the print as where once stood proud and shiny components, only black and blown remains will be left. This is quite a headache to repair but with a bit of patience and determination, with time being on your side, it is quite possible. You'll certainly end up replacing the SMPSU chip, which in the circuit (that of the Kristel 1428) is an IP3842N. R 507 (22 ohm) would be cooked. R 513 (0.22 ohm) would be most likely open circuit by now. Zener diode ZD 502 (18v) would also be found to be shorted. Before you actually apply juice again to the circuits, a short prayer won't do any harm as having to go through the same thing once again can be quite a let down.

Having said all that, one can't ignore the fact that all it could be would be a dry joint on the Euro pcb-mounted socket's pins. This can occur if the mains feed cable is pushed against the back of the chassis causing undue stress on the socket which over time, would break its solder joints and hence would inhibit any voltage entering the monitor, result of that would be a dead monitor. I've also found the actual printed board to be cracked due to the extreme pressure being exerted in the area.

This is just an example of what can be found if your monitor is dead. I'll tackle the other points raised in the article as I go along in this line of what can cause your monitor not to work well and how to go about fault finding it.

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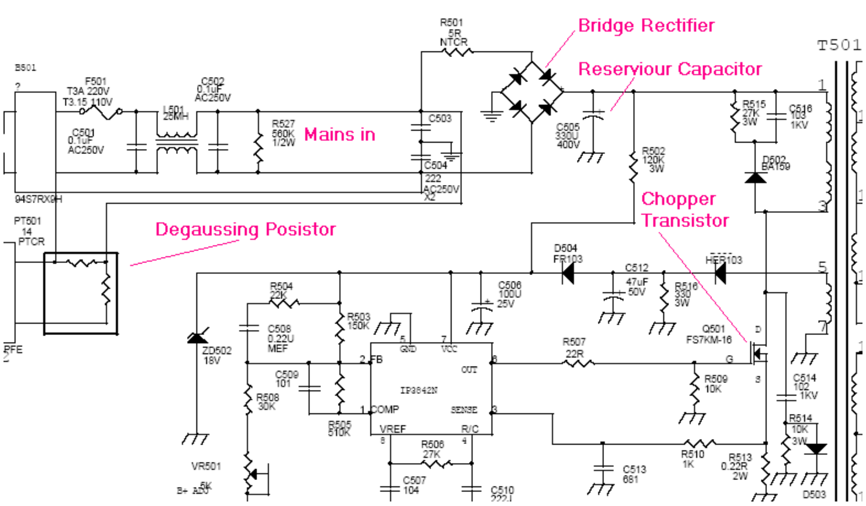


Quick Simple Repairs # 43

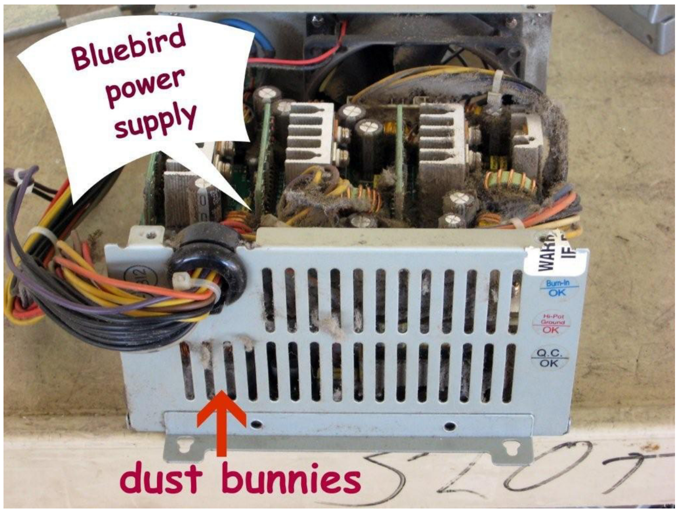
By Pat Porath

WMS Upright "Bluebird" Power Supplies

Some of our technicians went through and did some preventive maintenance on all of our upright "Bluebird" power supplies. It is the one located on the far right corner of the game, held down by one small bolt. It also has three connectors on it. One is 110vac going into it and the other two have DC coming out. The units were taken out of the game, taken outdoors, and the covers taken off. Then, with compressed air, the power supplies were blown out so they could "breathe" once again. The ones that I removed had HUGE dust bunnies in them! Not all, but most of them were pretty bad. (I only removed 12; a different shift completed the rest.) If a power supply can't breathe and have air circulate properly through it, the unit will overheat and fail. It took some time to complete the whole floor (a total of 1409 games, around one third are WMS) but the "life span" has definitely increased. Kind of like maintenance on a car. If the oil in the engine isn't changed, the life span of the engine is decreased. The car will still run for a while but not nearly as long if it was maintained properly. The same thing with a slot machine. Slot attendants here use an "air pig" and blow out bill acceptors and ticket printers as well. With modern slot machines, a little bit of maintenance can go a long way.

IGT S2000 that wouldn't cashout credits

I was called to a S2000 in which the customers $112.00 wouldn't cashout. I checked the button to see if the button was in fact attached to the switch. It was because when depressed it made the "clicking" noise that it was supposed to. It did not mean that the button was definitely good; it meant that there was a good chance that it was OK. The game was then turned off and the three I/O cards and main processor boards were reseated. Next it was turned back on and the lady's credits started to cashout. Then, there was a ticket error. What was going to happen next to this game? Luckily the validation number did print so we took it to the cashier cage and she finally received her credit. Why didn't the credits initially cash out? I would say that the door I/O card may have been loose. From the hard count team and slot attendants opening and closing the door, once in a while one comes a little bit loose. If the card is loose, the buttons on the player panel simply won't work. I'm not 100% positive but that would be my guess with this particular game. A quick reboot and checking to see if all of the boards were snug got this game back in operation.



IGT S2000 - Netplex Error

When the machine was turned on, all it would display on the VFD was something like "waiting for Netplex devices to load" and that was it. Every time a part was swapped with a game next door the same error would appear and the game would not go into play mode. All kinds of connections were checked, even some were disconnected, such as disconnecting the seven-segment display and the denomination touch panel, and leaving only the VFD plugged in. If the seven-segment display had a short in it, with it disconnected, the game should act normally (well, normal for a slot machine).The I/O cards were swapped out because the card or cards in the door have to do with the inputs and outputs of the door, such as a display. I even grabbed a spare main processor board, swapped flash boards, and still no change in the error. I was starting to think what to do next. Many of the connections have been checked to make sure nothing came loose. The connections on the door and on the backplane board, all of them looked OK. I even tried a trick called "zeroing the Netplex." That is where the Netplex devices (complex communication devices) such as the bill acceptor, the ticket printer, the monitor (if it has one) and the VFD are disconnected with power off. With the devices unplugged when the game is turned on it "looks" for the parts that aren't there. You have to leave the game turned on long enough to fully boot up. When the games used coin, it was when the coin diverter solenoid clicked. Once the game has been turned off and all the devices put back in and the game turned on again, it looks and establishes "fresh" communication with the devices once again. This trick doesn't always work, but sometimes it does.

Back to the problem at hand. The game won't boot up. We know that there is some good power in the game simply because there is information on the display. We also know that the main processor and all of the I/O cards are good because they were either swapped or changed. I did not want to change out the backplane board if it didn't need to be. As most of us know, it takes some time to do that. What was left other than the power supply? I've seen in other cases where games would act very weird and have the power supply be the problem. So I swapped out the power supply that is located behind the reels (S2000 upright stepper game) and when it was turned back on. BINGO! WE HAVE A BINGO! The game came back to life. I let out a cry of victory, "Yes! That was it! Yes!" The girls at the check cashing counter were looking at me kind of funny but I didn't care. The game was running again. I headed off to the shop to get a spare to put in the game next door that I was using for troubleshooting and both games were running. I checked

game options just to make sure that none were lost and all were in fact held.

NOTE: Always check the wattage of power supply that you took out and MAKE sure it is replaced with the same kind. An S2000 looks exactly the same as an IGT 2.5 (such as the "Wheel of Fortune Las Vegas") but they are different wattage. So be sure to check the sticker, if it says 300 watts, only replace it with 300 watts. With the bad power supply changed out, the game was back up and running.

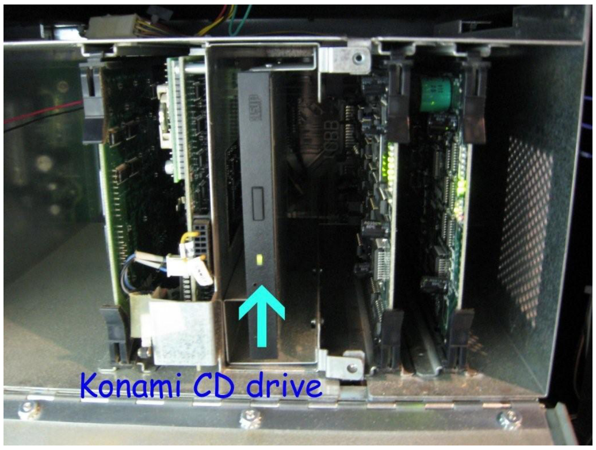
WMS Upright Bluebird Door Open Problems

A customer would be playing the game (a popular multi-denomination) and a door switch would trip. This caused a door to show open and interrupted the customer's play. A second or two later, the door would show closed on its own. Another problem with the game was, on our "dispatch system" (it's a computer system that receives signals from games and a slot attendant calls them over the radio, such as "Need a slot attendant in location X for a payout.") the game would show a memory error. At the game there wasn't a memory error, only door open errors. I checked the "event history" and it showed there had been top box door opens and main door opens on it. So, what was bad? Being that the game was a standard upright stepper without a topbox bonus device, it didn't even have a top box switch that I knew of. We tried a few things with it, but nothing helped the problem. The RAM had been cleared, and even the main processor board had been replaced. The main door switch looked fine.

I needed to call for help on this one. In the past, if a Bluebird had door open problems during play and it would show closed shortly after on its own, sometimes part of the switch assembly would be loose. Tighten up the "door striker" that pushes on the switch and there you go, it's fixed. This was not the case with this game. All of the switches that I could see, and switch assemblies were fine. I made a call to our WMS tech and he mentioned that he had seen a power supply, bad main door switch, connections on the backplane, or even a bad backplane board be the problem. This gave me something to work with. I wasn't sure what to do with it. I replaced the power supply and went to replace the main door switch. When I pulled the number 3, 4, and 5 reels, I saw the problem right away. What do we have here? Not one, but TWO bare wires! Somehow the wires were rubbing on the 5th reel and with time, the copper got exposed. When the two wires touched each other, it would cause a door to show open. Sometimes when the reel spun the wires would touch each other, and other times it wouldn't. I repaired the wires and tucked them far out of the way so they would not even come close to the reel. I haven't even heard a peep out of the game since. Without a doubt, the bare wires were the problem.

Konami Upright Video "CD error"

While talking to the previous shift, I was told that there was an upright video Konami shut down that had a "CD error." I was checking out the game and noticed that the CD drive didn't have any power. Come to find out the connector in the back of it was loose and when I tried to eject the CD there were a few sparks (not a good thing). The game was turned off right away and the connector put back in place. Knowing that



sparks were very bad, what did it short out, just the drive itself or did it take out an I/O board, maybe even the main processor? If I was lucky, it only blew a fuse. When the game was turned back on, a "24vdc error" appeared. It didn't matter what I tried, the error wouldn't clear.

Sometimes when the reset key is turned errors will clear, such as a "logic door accessed." Simply turn the keyswitch and the error goes away. A co-worker looked up the error in the service manual and it stated that possibly a circuit breaker tripped on an I/O board or a fuse blew. I checked all of the fuses and they were OK. What was the deal with a "circuit breaker" on an upright Konami video game? I have never heard of it. (I been working on slots now for 13 and a half years and never heard of it!) One of the two I/O boards was removed and right away I saw two small circuit breakers' one of them was in fact tripped! The tiny white button was sticking out indicating that it was, because the other white button was in a downward position. Instead of burning up a component or two on the I/O board, one of the two breakers tripped. In this particular case, the malfunction was a loose power connection to the CD drive. The repair was to simply reset the circuit breaker on the I/O board.

A UPS for a Progressive System

I recently installed a UPS for our "prize bank progressive" system. For those that don't know, a UPS doesn't mean the "guys in brown" and United Parcel Service. In this case UPS stands for Uninterruptable Power Supply. They are also known as a CPS, which stands for "Continuous Power Supply." They are a battery backup unit that when connected to a device, maintains a continuous supply of power when the utility power is out. It is different than a backup generator where there is a

second or so of "switch time." This would cause a computer to shut down. When a UPS is connected to a computer, telecommunication equipment, or a Mikohn controller, it provides uninterrupted power to the devices. Two different types are "off-line" and "online." An "off-line" UPS stays idle until a power failure happens, then switches from utility power to its own power almost instantly. An "online" UPS continuously powers the protected devices from its own energy in the battery while replenishing itself from the utility AC. They can also provide protection against common power issues, and are used for power conditioning. UPS units come in a wide variety of sizes, from the small ones used to backup a personal computer (around 200 VA) to huge devices that can backup entire data centers. The "protection time" depends on the UPS rating and the amount current that is being drawn. I was told a UPS that is rated at 300 watts will backup a Mikohn controller for around 20 minutes. A personal computer may be around 15 minutes, once again it depends on the amount that is drawn.

Why did I install a UPS for our "prize bank progressive" Mikohn controller? It was installed not only to provide "line conditioning" (power spikes, brown outs, and low AC voltage) but to provide an UNINTERUPTED power supply to the controller. If (when) the utility power goes out because of a bad thunderstorm or what ever the case may be (our power is pretty good) the UPS maintains CONSTANT power to the controller so when something does happen and the power goes out for a few minutes, the controller will not reboot. We don't have any of our games on a generator so they will reboot but not the controller. The type that I installed was a "Tripp Lite Internet Office" UPS. It is rated at 300 watts max. Once the unit is installed, the system should stay running during a minimal power outage or a brown out. When we do have a power interruption and I'm on duty, I'm going to check out the "Prize Bank Progressive" to see how well it does in fact work.

IGT "Trimline" Bill Acceptor "CRC" Mismatch

Have you ever run across a "Trimline" that displayed a "BV CRC MISMATCH?" I recently ran into one, and then I had to remember where (in the game software) it was to clear the error. I did remember that it was a bit tricky to find. The game was an IGT upright "Trimline" game with a UBA 10 bill acceptor in it. I don't really know what initially caused the error but the game needed to be made playable again. It is one of our popular multi-denomination games with 1, 2, 5, and 25 cents on it.

What does CRC even mean? Well, it is short for Cyclic Redundancy Check. It's an error checking system that performs mathematical functions on data in order to test their validity. You are likely familiar with the CRC Checksum, used to test the integrity of memory devices such as EPROMS. When you "Kobetron" a chip, you are testing its CRC Checksum. Another way to put it, the game had a CRC error because of a communication error between the microprocessor and the BV, thus resulting in the "BV CRC MISMATCH" that was displayed on the screen.

How does a tech clear the error? Simply press the white diagnostic button which is located behind the main game LCD. Next, select the "setup" tab, then select "peripheral devices." In that area of the menu there should be a small tab that reads "CLEAR BV CRC." Press the tab and in a few seconds (if nothing major is wrong) it will clear the error. Close the door of the game and the bill acceptor light should come on within 10 seconds. The screen should be free of errors, if not try opening and re-closing the main slot door once again. If the bill acceptor light does not light up (ready to accept a bill or ticket) then there may be other problems such as a

jammed bill or ticket in the stacker box, a bad bill acceptor, or the game may even think that one of its doors is still in an open status. If the game thinks a door is open, it won't accept bills or tickets, and there won't be a large error on the screen. Only in one of the corners of the screen, it would show "door open m," or maybe even a "door open b." But, if you have a "BV CRC MISMATCH" then select the tabs as described and the game should be OK.

WBA 13-ss Wouldn't Accept a Ticket on Test Bench

I noticed that there was a JCM WBA -13ss (EPROM memory type) bill acceptor on the bench that had a note on it. The note read "Won't accept tickets." At first I first thought that it was only dirt, grime, and a calibration problem. Boy was I ever wrong. I had cleaned and calibrated the bill acceptor head and it took bills perfectly, it still would not accept a ticket though. Why not try a different bill head? I looked over at the spare bill acceptor parts and we happened to have 4 spares on the shelf, so I installed it and calibrated the unit once again. Yet again, it would not accept a ticket. What was going on here? I wasn't really sure, so I asked a co-worker. I learned that there was a

DIP switch that had to be turned on. It only affected the WBA -13ss that used an EPROM. So, after a bit of research, my co-worker found it and showed me what to do. The bill acceptor was A-OK, only a DIP switch had to be turned to the ON position after it "cycled properly" in test mode. Here is how it works: First turn ON DIPS 1, 2, 3, and 8 then power up the unit. Next, turn DIP 8 OFF, now the unit should cycle as it would in a game and it is ready to accept bills. After it is finished with the "cycle," turn DIP 1 to the ON position. Now the unit is ready to accept tickets on the test bench. As I found out, with DIP 1 in the OFF position during test mode, the unit will NOT accept a ticket on the bench. This only applies to the WBA - 13ss with EPROM type memory. I was happy to find out that there was in fact a logical explanation as to why it didn't accept a ticket. Now I know.

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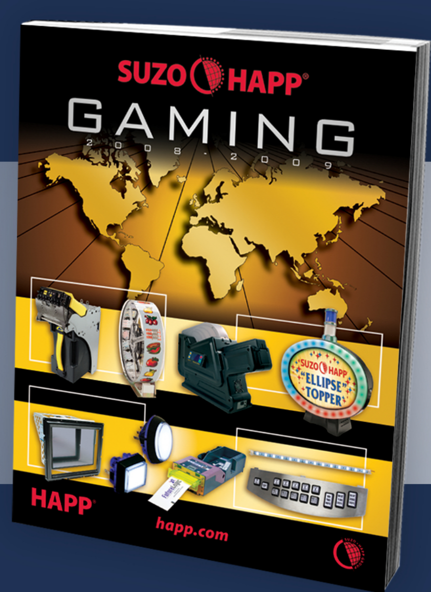

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