Slot Tech Magazine

February 2009

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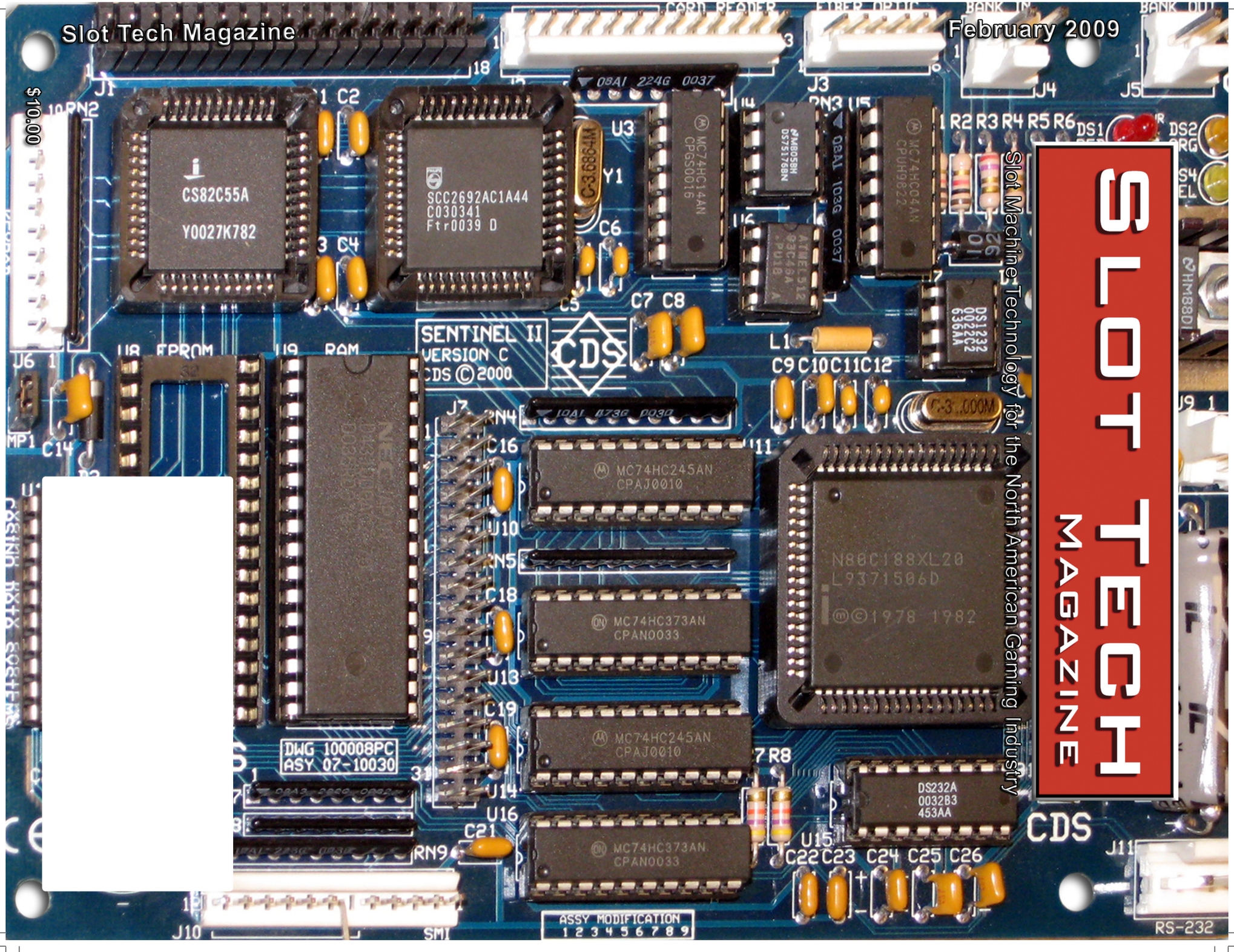

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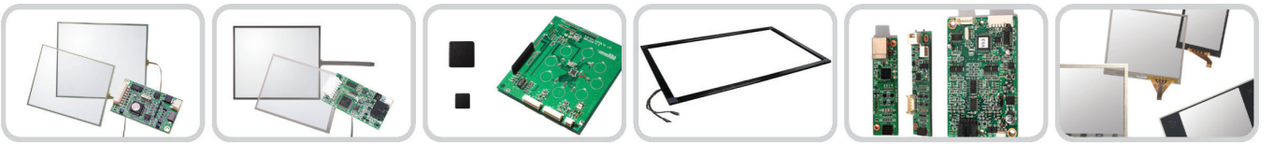

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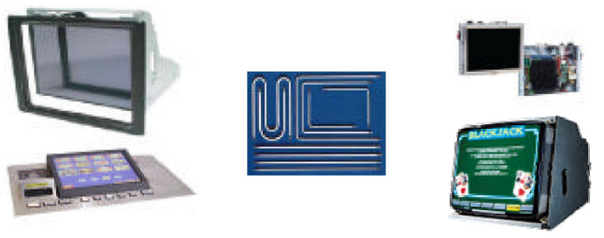

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Inside Slot Tech Magazine

February 2009

Every now and then, we revisit the subject of electrolytic capacitor failure here in the pages of Slot Tech Magazine. We haven't done it in a while so we're doing again now. The reason? I still encounter lots of casino techs that are not using a proper ESR meter to find bad electrolytic capacitors (our #1 failure item) and locate them quickly and in-circuit without unsoldering them to test them. There's an easy way to do all that and if you're not using a CapAnalyzer 88A to find bad electrolytic capacitors, you're making your life as a technician more difficult than it has to be.

You've seen the ad for this meter here in Slot Tech Magazine but believe me, I have been a fan of this unit for a long time and the fact that they advertise has absolutely no influence on my unqualified praise for this inexpensive (it's just $209) and indispensable device. It has enabled me (and my students too) to repair thousands of dollars worth or CRT monitors, LCD monitors, power supplies and other casino electronics, quickly and accurately with just the most basic knowledge of electronics required. So, if you need to learn a bit about electrolytic capacitors or you're up for a bit of review, turn to "Electrolytic Capacitors and ESR" beginning on page six.

I am not a player. I'll easily admit that there is just nothing about gambling that interests me in the slightest. I suppose that's good, considering that I spend a great deal of time at casinos.

However, every now and then I'll find myself in a casino, on the gaming floor with a cup of coffee in my hand and absolutely nothing to do. I can't play a slot machine. I'm sorry and my apologies to the game designers that have worked so hard to produce an entertaining game but I'd rather stare at a blank wall than play a slot machine. It's just as entertaining (to me) and a lot cheaper. On the other hand, if I can find a nice video poker machine, I will sit down and play, not to gamble so much as to stave off boredom. My game of choice is a Jacks or Better machine and if I can find and old Player's Edge + slant top or bar top, I am good to go.

Unfortunately, these machines are becoming harder to find as they are being retired from service for one unfortunate reason, a glass shortage. In this case "glass" is the monitor industry's slang term for CRTs and the 13 inch picture tubes used in the old video poker machines just aren't being manufactured any longer. Scratch another industry wiped off the face of the planet by advances in technology. What a shame to have to replace a perfectly usable machine with an unparalleled ROI and 100% functional electronics just because the CRT has worn out after a decade or more of 24/7 operation and a replacement is unavailable.

Or is it? You may not be able to replace the CRT itself but now you can keep the machine in operation by replacing the entire monitor with a drop-in LCD replacement monitor from Ceronix. This replacement LCD is able to handle the so-called "standard resolution" or 640 X 480 "CGA" resolution that is used by these popular machines. As a bonus, the A to D converter in the new LCD monitor upsamples the image with full anti-aliasing to the panel's native resolution and in the process, provides players with a newer, brighter, sharper face to an old friend. Slot techs will be happy to know that, as with all Ceronix monitors (both CRT and LCD), no color adjustments are necessary, assuring that every game in the bank will have a uniform appearance. For more, turn to page 19.

See you at the casino.

Randy Fromm

Randy Fromm - Publisher

Randy Fromm

Randy Fromm's
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Electrolytic Capacitors and ESR

Electrolytic capacitor failure is responsible for many of the problems we encounter in our industry. Power supplies use a lot of them as we have seen time and time again here in Slot Tech Magazine and very often, repair is a simple matter of replacing electrolytic capacitors that are obviously bad with their swollen, dome-shaped tops. You don't need to be an electronic genius, you just need to be handy with a soldering iron and have a good stock of replacement capacitors on hand.

On the other hand, bad electrolytic capacitors are not always so cooperative. They do not necessarily look bad nor do they manifest the failure with any outward change in appearance at all. Locating a bad electrolytic capacitor can be the easiest thing in the world when it looks bad or it can be a nightmare when it doesn't. That having been said, bad electrolytic capacitors that still look perfect can still be the easiest thing in the world to locate if you have the right piece of test equipment. I'll tell you about it later on but I'm going to make you learn something about electrolytic capacitors first.

Capacitor History

The first electrolytic capacitor was manufactured in Germany around one hundred years ago. In the 1920s, engineers were looking for a way to eliminate the bulky and heavy 90 volt batteries that were needed to operate the vacuum tubes in radio receivers. The result was the development of "battery eliminators" which required the use of electrolytic capacitors as the filter elements. Of course, we now know these units as power supplies.

Early electrolytic capacitors were wet types which used a liquid electrolyte much as today's automobile batteries do. Naturally, these capacitors had to be mounted vertically to prevent the electrolyte from spilling all over the place. The dry electrolytic capacitor first appeared around 1928, making it possible to mount the capacitor on its side or even upside down.

Today's electrolytic capacitors are made of paper and a couple of strips of aluminum foil. On one of the foil strips, a very thin film of aluminum oxide is created through an electrochemical process. The foil strip becomes the positive lead or "anode" while the aluminum oxide forms an insulating boundary known as the "dielectric" of the capacitor. The second strip of aluminum is used as the negative lead or "cathode" connection. But placing the cathode foil directly against the thin dielectric would puncture it, causing a short circuit. Instead, a system of paper spacers is employed to separate the foils. This paper is soaked in a highly conductive electrolyte solution (hence the name "electrolytic" capacitor). This assures intimate contact with the dielectric and the cathode foil. In fact, the cathode foil serves only as the electrical connection to the electrolyte-soaked paper which is actually the true cathode of the capacitor.

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8480-Single RAW cold cathode lamp for 10 inch LCD monitor in IGT games

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#9670- Single RAW cold cathode lamp for 15 inch LCD monitor in IGT games

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FOR BALLY GAMES

#8650- Single cold cathode lamp assembly for Bally IView player tracking system 6.2 inch "IDW" LCD

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Capacitor Specifications

There are three main capacitor specifications:

Capacitance

The capacitance of a capacitor is sort of a measurement of how many electrons the capacitor will store at a certain voltage. If you think of a capacitor as a water storage tank, the capacitance is kind of the same as the capacity of the tank. It's the number of gallons the tank will store. Our unit of capacitance is the farad, named for Michael Faraday. If it helps you (and sorry, but it won't) a charge of one coulomb (6.241506×10^{18} electrons) will be stored by a one farad capacitor with the application of a one volt potential. Aren't you glad you asked?

But even a single farad is absolutely gigantic! Most of the time, we are working with electrolytic capacitors that are rated in microfarads or millionths of a farad. Typically, we see electrolytic capacitors in the .47 to 4700 microfarad range although capacitors of 10,000 microfarads and higher are not uncommon as secondary filter capacitors in power supplies.

Voltage

The voltage rating of a capacitor is the maximum voltage it can handle between the two terminals. It is not a rating of how much the capacitor "puts out." That is to say, a 25 volt capacitor, charged by a 12 volt source, has 12 volts across it.

Temperature

Pretty much self-explanatory. The temperature rating of an electrolytic capacitor is the maximum operating temperature. There are two, commonly available temperature ratings for electrolytic capacitors: 85°C and 105°C. Never use 85°C electrolytic capacitors in slot machines. They are less expensive to purchase but they are not suitable for our use in gaming.

Life Expectancy

The life expectancy of electrolytic capacitors varies quite a bit. There are a number of variables. One is the quality of capacitor itself. For example, one major capacitor manufacturer offers four grades of components: a "commercial" grade that has a normal life expectancy of 3-5 years, a "computer" grade with a life expectancy

From top to bottom, this is what's inside an electrolytic capacitor. It's two strips of aluminum foil, separated by two strips of paper (soaked in liquid electrolyte) and rolled up. You can see that it's quite wet. When the electrolyte dries out, the capacitor's ESR increases causing problems.

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of 5-10 years, a "long life" grade with a life of 10-20 years and a "premium" grade that also has a life span of 10-20 years as well as a wider range of operating temperatures.

And speaking of temperature, this is one factor that has an enormous effect on capacitor longevity. In fact, capacitor life expectancy is doubled for each decrease of 10 degrees Celsius in operating temperature. This speaks highly for the proper operation and maintenance of cooling fans in slot machines, notorious for being very hot inside.

Another factor in the life expectancy of electrolytic capacitors is the operating voltage. For example, operating a capacitor at 80% of its rated maximum voltage will reduce the failure rate to 1/3 of that suffered by the same capacitor operated at 100% of the rated maximum voltage. In most cases however, capacitors are rarely operated close to their maximum voltage. An engineer will generally call for a capacitor with a voltage rating that allows a generous margin of safety.

So, what is it? What does it do?

Electrolytic capacitors can perform a variety of tasks. They are used to filter or tune a signal, block DC or pass AC, couple a signal from one circuit to another, suppress noise or even help start a motor!

In its most basic form, it's easiest to think of an electrolytic capacitor as a rechargeable battery. Connect a discharged electrolytic capacitor to a source and it will charge. Connect a charged electrolytic capacitor to a load and it will discharge. However, unlike a battery that can take many minutes or even hours to charge, an electrolytic capacitor can be charged in a fraction of a second. It can also discharge just as quickly when the circuit requires it to do so.

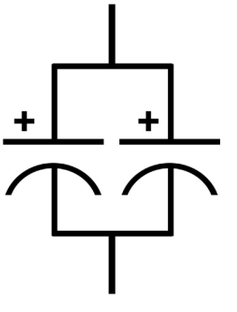
This is an important point and bears repeating. In order to function properly, an electrolytic capacitor must be able to charge quickly. This means that large amounts of electric current (measured in amperes) must be able to flow into the capacitor. Likewise, when we need to use the energy stored in the electrolytic capacitor, we might need it in a hurry, and lots of it! Large amounts of electric current must be able to flow out of the electrolytic capacitor as well. If anything happens to impede the current flow in and out of the electrolytic capacitor, bad things can happen. Get the feeling that I'm leading up to something? I am. You'll see what I mean later on.

Polarized Capacitors

Like a battery, most electrolytic capacitors are "polarized." That is, they have a positive terminal and a negative terminal. The negative lead is marked on the side of the case. Additionally, on capacitors with radial leads (where the two leads come out the bottom of the capacitor) the positive lead is usually the longer of the two. If you inadvertently install one backwards, it will probably blow up like an M-80 firecracker! Most modern electrolytic capacitors have a safety vent that will open up to release the excess pressure should this occur. The vent is simply a scored area on the top of the aluminum case that allows the case to break open instead of shooting off like a missile.

Capacitors in Parallel

Capacitors can also be connected in parallel to increase capacitance. When capacitors are connected in a parallel circuit, their capacitance is added together. If, for example, you needed a 1000 microfarad capacitor, you could parallel two, 470 microfarad capacitors. This would give you a total of 940 microfarads. You could also parallel three, 300 microfarad capacitors for a total of 990 microfarads. Since electrolytic capacitors have a fairly wide tolerance, this will give you a good approximation of the 1000 microfarad capacitor you need. When capacitors are

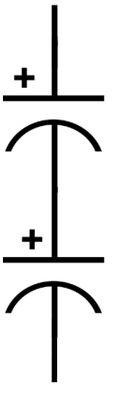


connected in parallel, their voltage rating is unaffected. If, in the above example, the voltage rating of the original 1000 microfarad capacitor was 25 volts, the replacement capacitors would have to be rated at a minimum of 25 volts as well. They would not need to be identical. Remember, you can always use a replacement capacitor with a higher voltage rating than the original so one might be rated at 25, another at 35 and a third one at 50 volts (or ever higher).

Why would you ever want to do this? As a repair technician, typically you would only do this in a pinch if you did not have the correct replacement component and you needed to get something up and running in a hurry. The design engineers sometimes have a reason for building a circuit that uses capacitors in parallel. It's not uncommon in power supplies to see secondary (output) filter capacitors in parallel in order to provide sufficient filtering at high output currents.

Capacitors in Series

Connecting capacitors in series is not a common practice in the gaming industry. When you connect capacitors in series, it is their voltage ratings that are added together. For example, connecting two, 16 volt capacitors in series will produce a 32 volt capacitor. Again, this would only be something that you would do if you were stuck for a part. It would never be advisable to mix voltage ratings when connecting capacitors in series. The voltage will be divided evenly across each of the capacitors, regardless of its voltage rating.



When you connect capacitors in series, something else happens as well. In addition to adding the voltage ratings together, the capacitance is affected too. If, for example, you connect two identical capacitors in series, the voltage will be doubled but the capacitance will be cut in half! If, for example, you connect two, 100 microfarad, 16 volt capacitors in series, you will end up with a 50 microfarad, 32 volt capacitor.

Non-Polarized Capacitors

Some electrolytic capacitors are "non-polarized" or "bi-polar" types. There is no positive or negative lead on

these capacitors. They are often identified by the letters "BP" printed on the case. If you need to replace a bi-polar electrolytic capacitor you can make your own from two regular, polarized capacitors. Select two capacitors of at least half the voltage rating and TWICE the capacitance as the bi-polar capacitor you need to replace. Connect them in series with their two negative leads tied together. You will now have a bi-polar capacitor of the correct value.

Capacitor Failure

Although electrolytic capacitors are all but guaranteed to fail eventually, short circuits in electrolytic capacitors are rare. The main cause of failure is that the electrolyte inside the capacitor will inevitably dry out. As mentioned earlier, this is especially true inside a slot machine where the environment is hot and dry 24 hours a day, seven days a week.

There are a couple of things that can happen as a capacitor's electrolyte dries out. One effect can be a decrease in capacitance. For example, a 3300 microfarad capacitor will, over time, decrease in value to 3000 microfarads, then 2000 microfarads and so on. In fact, it's not unusual for an electrolytic capacitor to open circuit completely.

The point at which a reduction in capacitance causes a malfunction depends on where the capacitor is being used. Some circuits can tolerate a great loss of capacitance without an apparent failure. The primary filter capacitor in a switched-mode power supply is a good example of this. A rare failure in and of itself, even if it fails to hold a charge as it should, the circuitry will simply increase the pulse width in order to compensate for the reduced primary voltage caused by the bad capacitor. If it's operating off 240 volt mains, the primary filter capacitor can be extremely bad before any outward symptom develops.

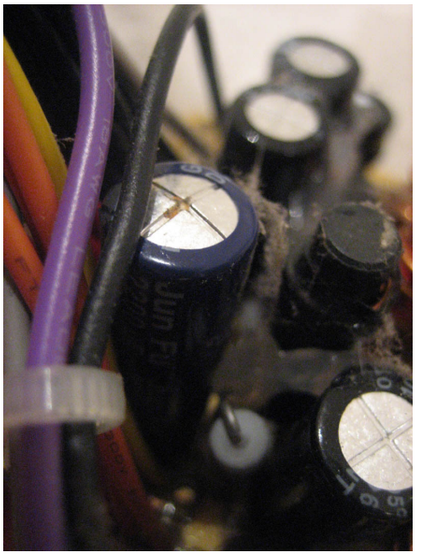
In other circuits, a small reduction in capacitance can cause problems to show up right away. CRT monitors are a good example of this as electrolytic capacitor failures can produce geometry issues such as a shrunken or otherwise distorted raster, brightness problems or even complete shutdown.

ESR

However, a much more important consideration is what the dried electrolyte does to the capacitor's ESR, its "equivalent series resistance." Hang on a second! What the heck is ESR? That's not even one of the capacitor's specifications, is it?

Well, yes and no. As outlined earlier, when you think of capacitor specifications, you generally think of the Big Three: capacitance (in Farads, Microfarads, whatever), voltage and temperature. However, there is another capacitor specification to consider and it's called ESR, which stands for "equivalent series resistance."

Do you remember earlier in this discussion I made the point that in order to function properly, an electrolytic capacitor has to be able to handle large



Bad electrolytic capacitors will often (but not always) have domed or bulging tops.

amounts of current as it charges and discharges? First-year electronics students know that current and resistance are inversely proportional meaning that if one goes up, the other goes down. In this case, we need to be able to charge an electrolytic capacitor quickly, using lots of current and what that infers is that its resistance must be low. High current=low resistance.

It's actually known as "equivalent series resistance" and, like all resistance measurements, the unit of resistance is the Ohm. The important thing to remember here is that LOW IS GOOD. The lower the better. The ESR is inversely proportional to the capacitance in Microfarads. Higher value capacitors will have lower ESR. For example, a 1mf capacitor might have an ESR of 10 Ohms where a good 1000 mf capacitor will have an ESR of a fraction of an ohm. Remember the mantra: LOW IS GOOD. LOW IS GOOD. LOW IS GOOD. If you measure any increase in ESR, no matter how small, the capacitor under test is to be treated with a great deal of suspicion.

In a nutshell, when the electrolyte in the capacitor dries out, the ESR increases. The actual capacitance may not drop by very much at all when this happens because the capacitor can still store the same number of electrons, but the increase in ESR makes it impossible to get them in and out fast enough. It's like trying to breath through a straw. Your lungs can hold all the air you need, but you can't get it in and out fast enough. The straw is a resistance and it is in series between your lungs and the air outside: ESR.

Finding the Bad Capacitor Using an ESR Meter

Troubleshooting and locating defective electrolytic capacitors has been a thorn in the side of all technicians for many years. The CapAnalyzer 88A ESR meter will help solve problems caused by electrolytic capacitors in audio, video, power supply, and system control circuits. It will allow you to locate bad capacitors easily without having to unsolder and test or cut up the pc board. Although you may have to unlearn some old-fashioned, slower methods,

those progressive enough to learn these tricks will be able to fix LCD slot monitors, CRT slot monitors and power supplies faster and easier than you ever thought possible.

There are several ways a capacitor can fail. As mentioned, in slot machines, the high temperatures inside the cabinet often cause electrolytic capacitors to dry up. In high-frequency circuits such as switched-mode power supplies, the capacitors tend to leak. In low-voltage circuits such as system control and low-voltage supplies, capacitors might short, partially or completely. Therefore, the technician must first check all electrolytic capacitors for DC Resistance (DCR) shorts or leakage, and then check for physically leaky or dried-up capacitors by measuring high-frequency Equivalent Series Resistance (ESR). These methods will not require a soldering iron, a service manual or any cutting tools. It will require some logical reasoning, good eyesight and some specialized equipment; your $29 DMM won't help you find the tough dogs.

Dried and Leaky Capacitors

As a capacitor dries up internally, it can become electrically leaky. Most of the caps in this category will be found in monitors. As the capacitor dries up, it can cause strange problems in the particular circuit it is in. For example, in the monitor's vertical section, it can cause vertical overlap, insufficient vertical or non-linear scanning. If the capacitor is in the power supply, jail bars or "hairy" interference may ride on the video. In one popular gaming monitor, a bad filter capacitor in the 7 VDC power supply causes loss of horizontal sync. Go figure! In the audio section it can cause distortion or low audio. In the system control supply, it can cause intermittent functions and microcontroller confusion, even a blank display. In the video circuits it can cause incorrect colors and/or a washed-out image.

Newer, digital monitors can also have these problems but with a different culprit: surface mounted capacitors.

Often, the problem will be less noticeable if the unit is left on for some time. That's because a dried-up capacitor will usually decrease its ESR with higher temperature.

Most technicians already know these symptoms and have an idea where on the board to start. The first step is visual observation. Vacuum all debris off the board and look for dark areas under each cap, for bulging tops and for shrunken and/or splitting covers.

On surface mount capacitors, look for the solder connections under the capacitor to have a cloudy look. This can be easily confused with perfectly good, lead-free solder joints (which always look sort of grainy) so be sure to compare to other solder joints on the PCB.

After visual observation and replacement of the obvious offenders, it's time to measure the rest of the electrolytic capacitors. The problem of measuring each capacitor is more difficult than measuring resistors, which can be measured in circuit quite easily with any cheap DMM. That is because any circuit that encompasses an electrolytic capacitor already has some DC resistance and some capacitance from other parts of the circuit. Some "capacitor checkers" claim to work in circuit but since they actually measure circuit capacitance and resistance, they give such erroneous readings that caps usually have to be unsoldered and re-measured out of circuit anyway. In fact, even some of the most expensive capacitor meters (over $2000) will not always measure capacitors accurately in circuit. Some meters measure the capacitance at two different frequencies and show it as two different readings. Most ESR meters will show a partially or fully shorted capacitor as "perfect."

Speaking of "ESR" meters, their designers already know that the trick to locating bad capacitors in-circuit is not to measure capacitance at all! Years of

testing by many technicians and engineers has shown that as a capacitor ages, its Equivalent Series Resistance increases. A perfect capacitance will measure as an open circuit at DC and will show less and less resistance as the frequency across it increases. Some inexpensive capacitor meters utilize this property by measuring a capacitor's impedance (Impedance is a type of resistance measurement. It is "AC resistance") at a fixed frequency such as 1 kHz and translating the reading to capacitance. In reality, checking a capacitor at 1 kHz only works if the capacitor is being used in a circuit that also operates at 1 kHz. VGA resolution monitor video circuits use frequencies into the megahertz and in PWM power supplies, the operating frequency is pegged to the horizontal scan rate so frequencies of 31.5 kHz and higher are commonly used. It makes more sense to forget about capacitance altogether and use our knowledge that high frequency ESR increases with age and as a capacitor dries up.

Several ESR capacitor checkers have appeared throughout the years. The originator was a simple meter that used 5O kHz and a simple mechanical meter. The technology wasn't good enough at that time to measure capacitors accurately. A more recent meter is a slightly improved version, still using an old-fashioned mechanical meter, but running at a more accurate 100 kHz. However, these meters have their limitations; they cannot check for leaky or shorted caps and the technician must individually discharge each capacitor before testing. Also, the cheap test probes add their own capacitance and readings varied depending on the position that the technician held the probes (and whether or not he or she was sweating!).

A more modern design for an in-circuit ESR/DCR tester is the CapAnalyzer 88A by EDS. This unique meter uses a test frequency higher than most others, automatically discharges the capacitor under test, checks for Low DCR, then checks and displays ESR on a 20 segment LED bar scale. It includes a low-capacitance, one-handed tweezer test probe, and beeps from one to five beeps depending on the ESR reading of the cap. Because it is microprocessor controlled, it has more features and is much more accurate than the older designs. Possibly its best attribute is a three-colored chart on the front panel that shows typical ESR readings of good, fair and bad caps depending on their capacitance.

The CapAnalyzer 88A claims 100% accuracy in circuit because of its testing parameters. The frequency is high enough to make the capacitor's actual capacitance insignificant, so it measures only the ESR. The high test frequency also helps isolate the capacitor under test from the rest of the circuit via the high inductance of the pc board copper foil. This frequency is also high enough to ignore any coils over 5 uH. ESR testing is

done with a calibrated low resistance at the test point which allows it to compensate for normal circuit resistance. Both DCR and ESR measurements are under 50 millivolts so that no active devices are turned on, therefore only the component at the test point will respond. However, because it checks DCR first, it will alert the technician immediately if the capacitor or anything else in that circuit is shorted or leaky, before it checks ESR. This test parameter (DCR OHMS SET ALERT) is user adjustable from zero to 500 ohms.

Using the CapAnalyzer 88A to Check Electrolytic Capacitors

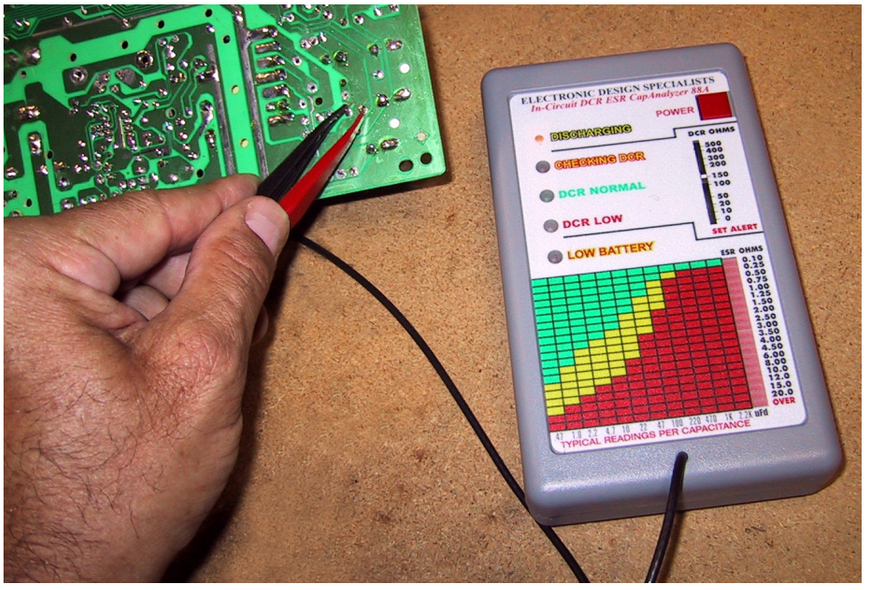
When the CapAnalyzer 88A is first turned on, after a second of internal calibration checks, it will briefly check all LEDs, multi-tone beeper and the battery. Then, it will flash the OVER LED slowly to indicate ready. The DCR OHMS slider set alert is normally set to about 150 ohms. To test an electrolytic, simply hold the tweezer test probe across the capacitor leads. Polarity does not matter. The CapAnalyzer will chirp once to let you know that you have a good connection and the DISCHARGING LED will turn on for a fraction of a second.

The first test is the DCR test. The CapAnalyzer will show either a NORMAL or LOW LED, depending on the setting of the DCR OHMS SET ALERT slider. If the slider is set to 50 ohms, the CapAnalyzer will sound an alarm and light the DCR LOW LED if the DC resistance is lower than 50 ohms. Most circuits will never show this low normally. However, in some circuits, the circuit's resistance might be lower or higher. In these cases, you may set the slider for as low a DC resistance as you expect the circuit resistance to be normally. For example, where the supply must power a 15 ohm load, you could set the slider to 10 ohms. The CapAnalyzer would treat any DC resistance above 10 ohms as normal and warn you if measured DC resistance is lower than 10 ohms. In fact, you can set the DCR SET ALERT anywhere from a fraction of an ohm by setting the slider all the way down to 0, to as high as 500 ohms DCR.

Be advised that if you have the slider set higher than 100 ohms and try to measure a very large electrolytic, the charging time to test the electrolytic may exceed the DCR test period and you may get a false DCR LOW, or the CapAnalyzer may try testing the capacitor over and over because of conflicting test results. Therefore, use 50 ohms as a guideline when measuring most medium to large electrolytic capacitors and use the values higher than 100 ohms when measuring small tantalum and surface-mounted capacitors. Surface-mounted tantalums can become leaky by as high as 500 ohms.

Capacitor Testing

As you touch and hold the probe across the cap, the unit will chirp once to indicate testing has started, will pass the DCR test, then will chirp one or more times depending on the ESR of



Using the Cap Analyzer to locate bad electrolytic capacitors in-circuit!

the cap. The CapAnalyzer 88A has been designed to chirp once if the ESR is less than one ohm, two chirps from one to two ohms, three chirps from two to three ohms, four chirps from four to eight ohms and five chirps from eight to 20 ohms. The handy three-color chart on the front panel shows typical ESR readings, so if a 2.2 uF capacitor chirps three times and shows 3.00 ohms ESR, the chart shows that this is in the green, good.

As a rule, some caps can show in the yellow area and may still work adequately. It is up to the technician to make the decision on whether to replace these questionable caps or not. However, any caps that show ESR in the red areas are out of spec and must be replaced.

Note that if an electrolytic capacitor is in such bad condition to be over 20 ohms ESR, the CapAnalyzer will treat it as an open circuit and will not even try to test it. The OVER indicator will continue to flash. Replace these caps, as they are bad, no matter what their capacitance is. If you wish to double-check the test probe at any time, simply short the probe contacts together and the CapAnalyzer will do a self-test. You can also check calibration at any time with a 10 ohm resistor: set the DCR OHMS alert to zero and measure across the resistor; the 10 ohm ESR LED should illuminate.

In some cases, you may find capacitors that are physically leaking, yet they check as perfect. Although the capacitor is leaking, it has not leaked enough electrolyte to render it defective and will still operate perfectly in the circuit . . . for a while. If you wish to avoid callbacks, replace them anyway.

NOTE: Although the CapAnalyzer automatically discharges capacitors before testing, remember that there are limits. If the capacitor is large enough and there is enough voltage stored to blow the ends off of the test probes, you will have to replace the probes as well as the resistors in the discharging circuit of the instrument. Therefore, use common sense when measuring electrolytic capacitors that may have a serious charge stored. If you damage the unit, it will appear to try to test a capacitor as soon as it is turned on. You can easily repair it yourself. See the website at eds-inc.com for instructions.

Quick ESR Test

Normally, the CapAnalyzer discharges the cap, then tests for DCR, then measures ESR. In many cases, you might know for sure that there are no shorted capacitors and might wish to save some time by eliminating the full

test and just want to quickly check the ESR. To put the CapAnalyzer 88A in this special Quick ESR test, turn the unit on while shorting the probes ends together. Instead of the multi-tone song, the CapAnalyzer will only beep twice and be ready for testing. Keep in mind that a shorted capacitor will show a low ESR, so we recommend using only the full test. This feature also uses less power and will result in longer battery life.

Low Battery Warning

The CapAnalyzer 88A uses four alkaline AAA batteries (6 VDC). Although continuous operating time is several hours, most users will only need to replace the batteries at three to six month periods. We advise to measure a few capacitors, and then turn off the CapAnalyzer when you find and replace the bad cap. If left on without being used, a three-minute warning timer will chirp three times every three minutes.

At 5.1 volts, the LOW BATTERY indicator will illuminate. The unit will still operate for some time on a low battery, until voltage falls to 4.9 volts, with a slight reduction in accuracy. Below 4.9 volts, the unit may ignore shorted capacitors, so a good test if you are not sure is to short the probe tips and see if the DCR LOW LED comes on and the alert sounds, as it should.

Do not attempt to use any external voltage source more than 6VDC. If you need to keep the CapAnalyzer on continuously, you may send your unit to EDS with a $29 check, and a power jack and specially modified external adapter will be supplied. Alternatively, you can install the AC adapter easily yourself with a drill and soldering iron; the adapter kit is $19.

If you need help or assistance, you may call for technical assistance at 561-487-6103. Also, we recommend that you check out the CapAnalyzer owners technical assistance page on our website at: http://www.eds-inc.com/eds88.html for any last-minute updates, FAQs, and modifications. - **STM**

13” CRTs Fade from Scene - LCD Replacements Now Available

Legacy display manufacturer Ceronix has announced the release of two new replacement kits for the Bally Game Maker and Game Maker Plus cabinets. These kits will allow you to take the old faded 13" CRTs out of the machines and replace them with a bright new 15" LCDs. This will give your Bally Game Makers the look of a new machine and enhance the play for your customers.

The LCD replacement monitor drops right in!

Kits come complete with new ABS bezel and can be installed in just a few minutes. Kits also come with the Ceronix four year limited warranty and are American made in Auburn, California.

For more information, contact worldwide Ceronix distributor Suzo-Happ or your local Ceronix Distributor. For a list of distributors, please visit the website at ceronix.com or contact Ceronix at 530-886-6400.

Quick and Simple Repairs #47

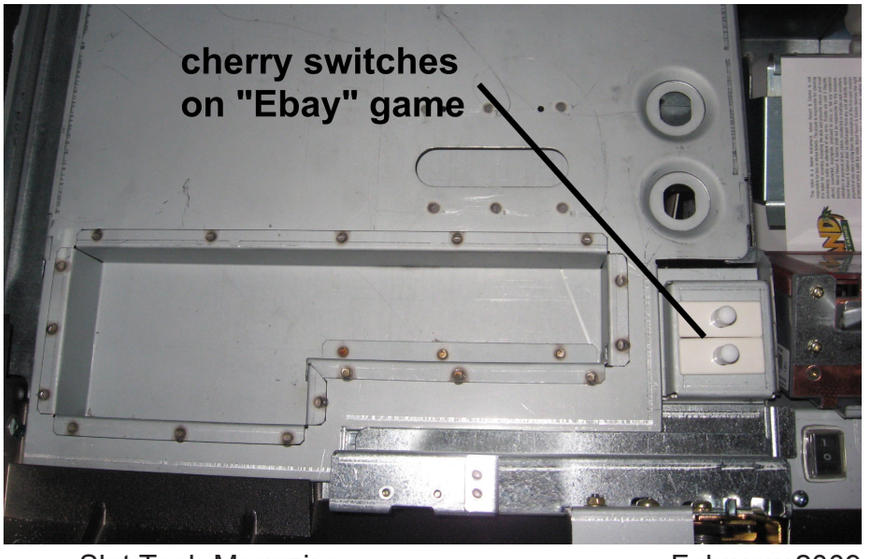
By Pat Porath

WMS Bluebird Video Slot With a "Signature Invalid" Error

Have you ever run across a Bluebird that showed a "signature invalid" error when the game was booting up? I was told that the CF game card was bad but wanted to double check it. I called our WMS tech and he asked me to check it so I did. The game was turned off so I fired it up to see what would happen. It seemed to boot up normally then, all of the sudden on the screen it showed a "signature invalid" error and wouldn't boot up past that particular point. After that, I called the WMS tech back and he thought the same thing; he thought it was indeed a bad OS card. Once replaced, the game was fine. So, if you have a "signature invalid" error that appears on a Bluebird during bootup, it may be a bad CF game card.

IGT AVP 2.5 Ebay Door Open M

I had a heck of a time getting the "door open M" to show closed on this particular game. At first, I looked at the main door optics. I tried to slightly adjust them, but it didn't seem to make a difference. Maybe the hopper door (this being a slant top game) wasn't closed properly. It was opened up and re-closed. Still the "door open M" remained. The M would go off the screen if the main door was closed quickly (not slammed shut) but when it was closed slowly, nothing would happen at all. I made sure the two main door Cherry switch connectors and wires were all in place; they looked fine. I later found that if you push on the main door itself towards the lower middle area, the door open M would go away. Maybe it WAS a cherry switch problem? I very slightly bent the main door cherry switch assembly toward the bill acceptor and shut the door once again. FINALLY it showed closed. All the while it was a Cherry switch problem. A simple "tweak" and the game was fine. Since they were slightly angled inward, the main door wouldn't put enough pressure on them to show a door closed. With the switches slightly angled to



the right, they work like they are supposed to.

Aristocrat SPC2 COM Board Wouldn't Clear

Have you ever had an Aristocrat SPC2 board that wouldn't clear and wouldn't communicate again, even after multiple RAM clears? What if all of the connections look OK too? At this point I used to replace the whole board, clear it, and the game would communicate with the system again. I was told that if nothing else seems to work, check the 3.5v battery. Recently a fellow slot tech had similar issues with the board and the battery was tested. Guess what? The battery was bad! He said he replaced it, and the board worked fine. He also said that he's going to order more because he has a bank of games that are the same age and wants to have the parts on hand when it happens again.

Aristocrat Slant Top With a "Printer Disconnected" Error

I had checked out almost everything on this particular game. I had swapped printers, the printer COM board, checked connections, reseated the main processor board and reseated the I/O board. Nothing seemed to help.

I knew that the printer had power (it happened to be a JCM type) because the bezel was lit up, but the "printer disconnected error" remained. I even checked the software. The printer was "enabled" and the other option was set at "Seiko." In the options "JCM" wasn't one of the selections (which was kind of weird) but the game next to it was set at "Seiko." This meant that it was in fact the correct setting (the options were Ithaca, Seiko, and NONE). I also checked the ribbon cable that goes from the printer to the printer COM board (AKA "power board"). It looked OK; I didn't see any nicks or bare wires.

I was starting to run out of ideas on what to try next. In my personal opinion, it was time to call an Aristocrat tech. He said to try swapping the complete printer assembly and the main I/O board. I swapped the I/O board first and the problem still remained. When I started to swap the complete printer assembly with the game next door, I noticed something. Could this be the problem? Was this the problem all along? How did it even happen? On a connector from the back of the printer to the backplane board, a pin was about HALF OUT OF THE CONNECTOR! In the middle of swapping parts I just stopped and stared at it for a moment. There was a very good chance that this was the problem the whole time. I took my small screwdriver and pushed the pin into the connector ALL THE WAY, like it was supposed to be, and put everything back together. Once again the game was turned back on and I had a "logic door open" from when I swapped I/O boards. I opened and closed the door once again, then shut the main slot door. The problem was gone and the game was fixed. To make sure that everything was working, I printed three test tickets. Each of them was perfect. Now I knew the game was A-OK.

IGT S2000 Main Door Very Difficult To Close

I was called to this specific game and the individual stated that the main door (on an upright game) was very difficult to open and close. I tried to lock the door myself, and without a doubt, there was a problem somewhere. I gave the latch assembly a quick inspection and didn't see anything out of the ordinary. I also checked the coin tray. Why the coin tray? On the S2000 coin tray there is a speaker and a speaker connector. If the tray isn't seated properly or if the connector gets smashed and broken, the tray won't fit correctly. If it doesn't, then there will be main door locking problems. The assembly will bind and not lock properly. Anyway, the tray did seat properly and was not the problem in this case. Next I checked the player tracking bracket because if it was removed and not properly put back on, the top part of the door will not close all of the way. This wasn't the problem either, the bracket looked fine. I thought I had checked all of the basics, now what? I had to think for a minute (kind of scary) and looked once more at the lock assembly itself. Upon further inspection, I noticed that on the "locking bar", one of the tabs was slightly bent. I used my "Leatherman Multi-purpose Pliers" and bent it back to where it looked like it was suppose to be. I started to lock the door and it seemed to be a bit better this time. So after ever so slightly bending all three of the tabs on the "locking bar", it finally locked easily. Simply a bit of "TLC" (tender loving care, not the learning channel) and the game was fine.

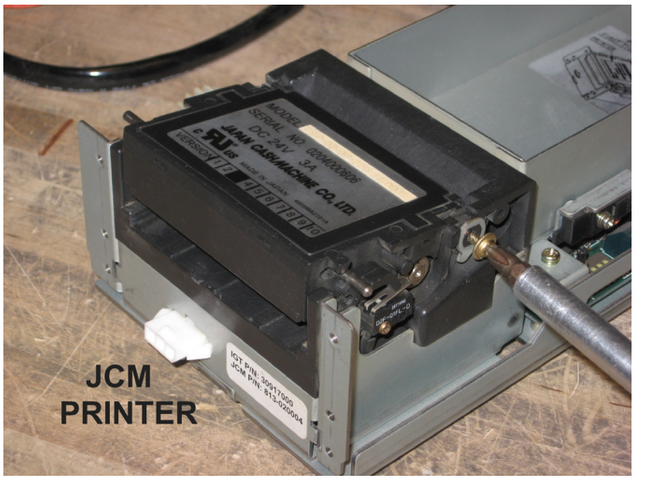
Unusual COM problem with a game and Oasis

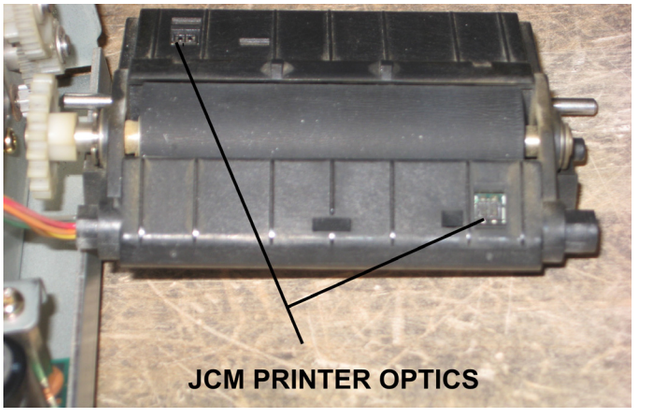
This was a weird one. I wish I had a totally logical explanation for this, but unfortunately I don't. To start off with, the slot attendant told me that the game wouldn't accept a ticket. He showed me that the bill accepter would take it in, and then reject it right away. The Oasis display was checked for a "main door OPEN and CLOSED" and it appeared to be ok. When the door was open the display read OPEN, and when the door was closed it read CLOSED. Usually this is a sign of good game and tracking system communication. The game software was checked too. The SAS channel was set at 3, and the address was 1, which was OK. I even checked the green COM LED on the Sentinel. That looked good too. It was flashing rapidly like it is supposed to. The interface cable (cable from game to Sentinel) was checked. It looked good at first glance. After a quick inspection, all looked ok. So now what? It still wouldn't take a ticket. Thinking to myself that this game is a tournament game and the interface cable is disconnected twice a week, maybe there is a problem somewhere that involves it. When looking closely at the cable which one end is connected to "J11" on the board, somehow it was on backwards! The three wires that come out of the connector are supposed to face AWAY from the board, not toward it! This was the problem. The cable was turned around and placed on the board properly and sure enough it worked. A ticket was tested and it accepted on the first try. It also printed a ticket too. This meant that the game was fine. It was weird that it still showed a door OPEN and CLOSED even though

it wasn't communicating properly, but it was alright now.

Paper Feed Problem on a JCM Printer

Have you run into a paper feed problem on a JCM ticket printer? I received a complaint that the game would not properly feed a ticket into the print head. I opened it up and noticed that there was some dust and dirt but nothing really major. I tried to feed the paper, but I didn't have any luck (or skill) either. No matter what I tried, the printer would not properly grab the ticket into the printer head. Since I did notice that there was some dust in it, maybe the unit only needed a good cleaning and it would be functional again. The printer was removed from the game and brought to the printer bench. I grabbed a spare, put it in the game, and printed some test tickets. The spare did in fact work OK and the game was back in play. Since I only had one good spare JCM printer on the shelf, I wanted to check and repair the bad one so I would have at least two good ones. When I opened up the printer head on the bench (with much better lighting than the gaming floor area I was at) I could see that one optic had more dust on it than the other. Actually the one looked horrible, how did it last this long without having problems earlier? Simply by removing one small screw, the top part of the print head comes right out of the housing. Care is needed though, as the cable is still connected to it. With the head part out and the cable still connected, the head is very easy to clean. I used a Q-tip and compressed air. Use the air to get rid of the dust and the Q-tip to wipe off the optic. Once clean, I put the unit back together and tested it in a game. Awesome. It fed properly





AND printed five test tickets. Dust on the optics, without a doubt, was the problem why it wouldn't properly feed a ticket into the print head. Now that it was clean and tested, it could go on the "good parts" shelf right next to the other JCM spare printer.

Oasis Sentinel Problem

I was called to a game where the Sentinel display was only a green color and didn't show any text. The machine also was "locked up" for a jackpot, so not only one problem but two. What was causing the problems? I looked at the Sentinel board and noticed that the green communication LED wasn't lit up. This told me that somewhere communication had been lost between the game, the Sentinel, and the system. Both the game and the Sentinel were rebooted, but it didn't help the problem. I looked at the COM in and COM out connections and they looked ok. How about a close inspection of the Sentinel board and SMI board to see if anything looks out of place?

"Hmm...Maybe this is the problem?" I thought to myself. An innocent ground wire where it wasn't supposed to be and it definitely was NOT grounded. The small wire was shorting something out in the middle area of the Sentinel board! The individual that installed the game interface cable did not connect the ground wire where it was supposed to be, thereby causing other problems. Right away, I removed power from the Sentinel and properly grounded the cable. This was an Aristocrat Viridian game interface cable. On one end, it has a three-pin connector that goes onto the Sentinel and a ground wire that is connected to the metal frame of the Sentinel board assembly.

Next, the main power to the game was turned off for a few seconds then back on. When I applied power to the Sentinel, I had a nice steady green COM LED but still only a green display WITHOUT text. The Sentinel was rebooted a few more times and it finally worked. My COM LED was flickering nicely and the Oasis display was working properly. With my floor card inserted, I opened and closed the main slot door a few times to make sure that I had "game to Sentinel" communication and I did. The Oasis display showed an OPEN and a CLOSED door. Everything looked good and the game was back online. I admit I think I got lucky on this one. A wire touching items on the Sentinel board while it has power isn't good. I thought for sure something would need to be replaced like a COM chip, an E-square chip, or even the EPROM. Nothing was replaced and around three hours later, at the end of my shift, I hadn't heard of any complaints about the machine. The repair looked like it worked with another game back online.

- Pat Porath
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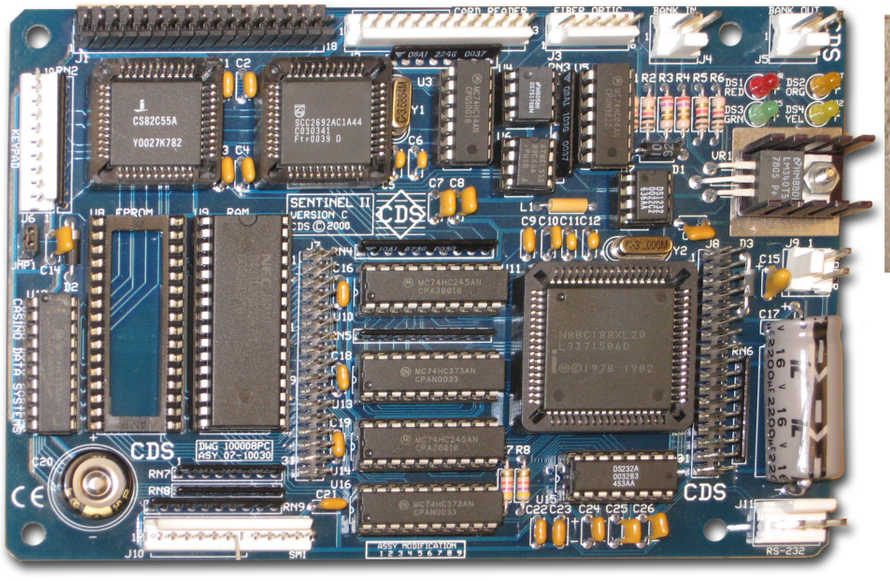

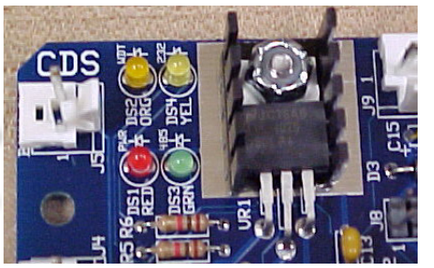

The Sentinel PCB and the LEDs

RANDY FROMM'S CASINO SCHOOL

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	LCD Monitors	Hands-On Repair Lab CRT Monitors, LCD Monitors, Power Supplies, etc.		FutureLogic Printers	JCM UBA Bill Acceptors	
One Week Intermediate Level Class	Power Supplies	CRT Monitors	LCD Monitors	Hands-On Repair Lab CRT Monitors, LCD Monitors, Power Supplies, etc.		
One Week Intermediate Level Class	Power Supplies	CRT Monitors	LCD Monitors Hands-On Repair Lab CRT Monitors, LCD Monitors, Power Supplies, etc.		JCM or FutureLogic or Ithaca or MEI	
Another One Week Alternative Class	LCD Monitors	Slot Ticket Printers	JCM UBA Bill Acceptor	OASIS Training		
One Week Class	OASIS Training		JCM UBA Training	FutureLogic Ticket Printers	3M Touch Systems	
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Four Day Class	Power Supplies	CRT Monitors	LCD Monitors	3M Touch Systems		

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Here is another way to look at the modules that are offered. This chart shows the modules and the duration of each one. You can select the modules you need for your class.

Module	0.5 Day	1 Day	2 Days	2.5 Days	3 Days
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LCD Monitor	■				
Touch Screens	■				
Power Supply		■			
CRT Monitor		■			
FutureLogic Printer		■			
Transact Printer		■			
JCM UBA		■			
OASIS Hardware			■		
Digital Electronics			■		
Basic Electronics				■	
Hands-on Repair Lab	■	■	■	■	■

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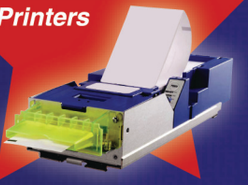

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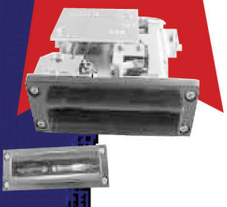

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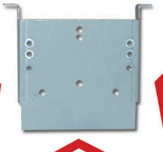

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