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Understanding the Principles
of the Microcontroller**

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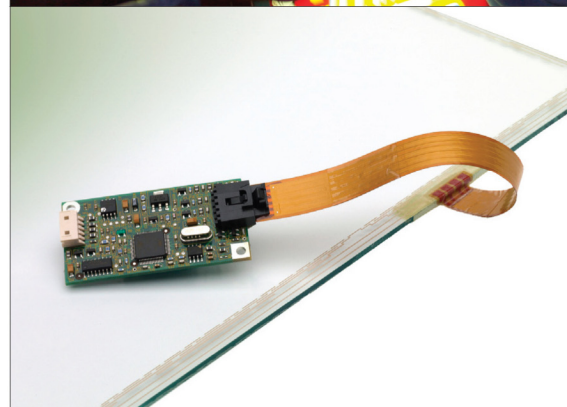$10.00

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Slot Tech Magazine

Randy Fromm

Dear Friends of Slot Tech Magazine,

Every now and then, I meet a technician who impresses me with his detailed knowledge of electronics and "how things work." You see, in general, as a repair technician, I am not generally overly concerned about "how things work." I am more concerned with "how things break." My job (as a repair tech) is simply to find the fault and replace the bad component(s) (or repair a bad solder joint or broken conductor, etc.). Or sure, I enjoy knowing precisely how a circuit is supposed to function but my bread-and-butter comes from fixing stuff.

However, the sole purpose of Slot Tech Magazine is education and the more you know about something, the easier it can be to fix. With this in mind, I reached out to super-tech Heno Kollar and asked him if he might consider penning an article for Slot Tech Magazine. You may know Heno better as "kondy73" on the Slot Tech Forum (slottechforum.com). In particular, I wanted him to concentrate on some of the more advanced topics that Slot Tech Magazine has ignored as of late. In general, I prefer that Slot Tech Magazine presents a mixture of "symptoms and solutions" (easy fixes such as those presented by the venerable Pat Porath) along with more advanced circuit analysis and educational articles. Half of what I know about electronics, I learned from Popular Electronics Magazine.

In his premier contribution, Mr. Kollar presents us with a detailed look at LCD monitors and how they REALLY work. As you read this article, please keep in mind that this is doubly awesome because English is not Heno's native language. He is from Slovakia. As such, the gear he works on may be sort of "Euro-centric" but the electronic principles are sound and universal, regardless.

Props to MotorCity Casino for hosting TechFest 26. MotorCity is a world-class property. Let me just say that we ate VERY WELL at TechFest 26. The hotel and the casino are both very much worth a visit. I was (still am) impressed by the property and, especially, all of the people who work there.

Randy Fromm

Publisher
Slot Tech Magazine

Next TechFest
will be held at
Mystic Lake Casino
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May 2013

Repairing LCD Monitors
Understanding the Principles of the Microcontroller

By Heno Kollar

This month, I want to outline how a normal LCD monitor works, as used either in the gaming machine or as a PC screen. I will describe the operating principles and procedures for the repair of complex defects in LCD monitors using VGA as a video source and LVDS LCD panel for displaying images.

Experienced technicians have routinely replaced old and faulty electrolytic capacitors by their loss of capacitance and other parameters directly affect the proper function of any electronic device, so I will skip this topic. This article discusses what to do if, after replacing the electrolytic capacitors in your LCD monitor, it is still not working properly.

Types of LCD monitors are different but all use the microcontroller to control the LCD monitor and video processor for A/D image processing - the converter which converts analog VGA signal to digital LVDS sig-

nal for the LCD panel.

Modern types also include input from the DVI (digital video interface) connector from which the digital video signal is converted again to LVDS. LVDS is the "low voltage, differential signaling" that is used to communicate between the monitor's electronics and the LCD panel itself.

Figure 1 shows a block diagram of our LCD monitor voltage of 12VDC powered from an external AC/DC power supply.

The figure follows that after power up (connect 12V) to

LCD monitor, charging the capacitor in the circuit resets the microcontroller. This means that several hundred milliseconds after power-on, the reset input logic level is "high," a logic "1." While charging the capacitor at the reset input, voltage is eventually reduced to logical "low" or zero (0 volts) which tells the microcontroller to start to execute the program. This program is the basic software for the LCD monitor and is stored in either the on-chip microcontroller (in the internal FlashROM) or in an externally located ROM memory package.
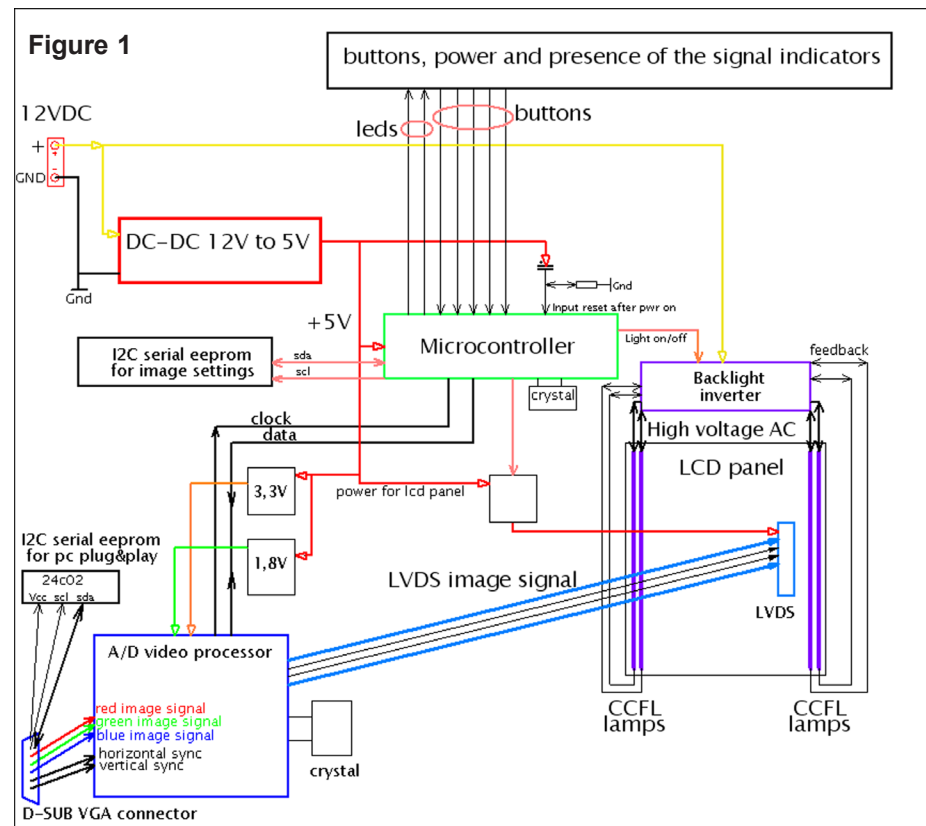
Figure 1

Figure 2 shows a typical configuration using SyncMOS SM89516 microcontroller with 128KB internal Flash ROM memory, an external EEPROM 24C16, DC-DC converter 12V to 5V with a control IC LM3485 and Realtec RTD2023B video processor which is powered by a 3.3 V and 1.8 V. The specific chips used will vary between manufacturers but the architecture is always the same.

Figure 3 shows a configuration where a video processor and microcontroller are both integrated into a single chip, a Genesis gm2621 with external memory serial SST25VF010 FlashROM, which is divided into the "program area" and

"EEPROM area" for user settings.

Figure 4 and Figure 5 shows a single chip Genesis gm2121 with external memory parallel FlashROM (PMC) PM39LV010 and also with external memory serial EEPROM 24C16.

One of the first steps and commands to the software microcontroller is reading the external serial I2C EEPROM (or FlashROM area EEPROM of external memory).
If the microcontroller detects that the memory is empty, then it immediately writes the default values for settings for the imaging parameters in this EEPROM. These imaging parameters include:

- basic values of brightness, color, contrast, picture size, etc.
- setting values for image processor mode and communication.

This method of storage in EEPROM has been chosen because of the universality of software, using different LCD panels of different sizes and various display modes depending on user settings but also on what type of software used by the manufacturer of the particular type of LCD monitor. So microcontroller software is set by the manufacturer of the new A/D board at the manufacturer and it will automatically put it in to an empty EEPROM, all the necessary information according to which version
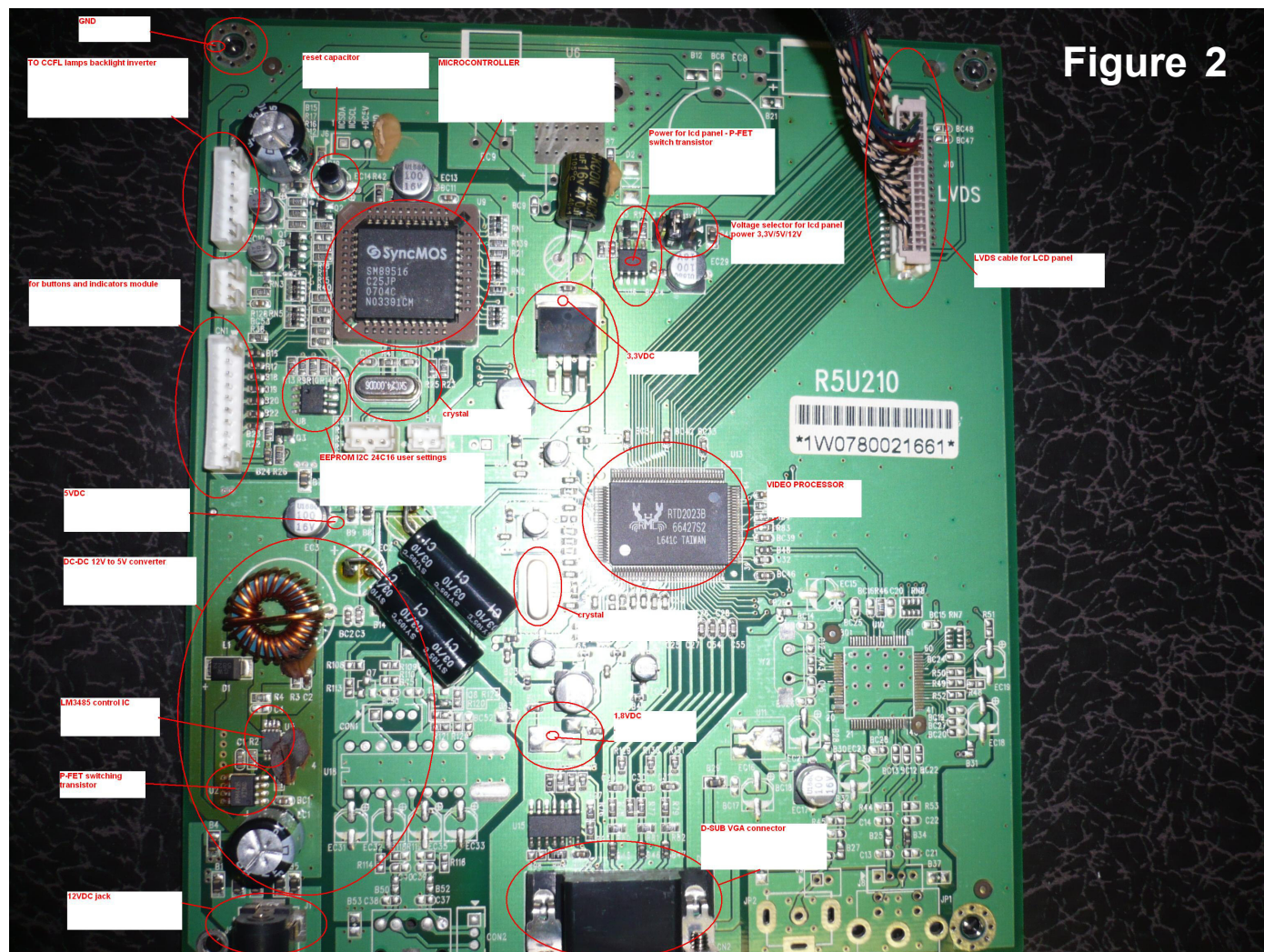

Figure 2

- **Cold Cathode Replacement Lamps** (for every slot machine in the world)
- **Player Tracking System CCFLs, Touch Screens and LCDs**
- **Bonus Screen CCFLs** ("L" shape, "U" shape and Straight) Also LCDs (6.4" and 7")

Single Cold cathode lamp assemblies for: IGT NexGen & Bally Iview Player Tracking Systems and WMS Bonus screen 6.4" LCD, also Konami bonus screen 7" LCDs ("L" shape CCFL and "U" shape CCFL)
Single RAW cold cathode lamps for all slot machine LCD sizes (10", 15", 17", 19", 20", 22", 26", 28", 32", 36" and more) used in all slot Manufacturers' games (Aristocrat, Atronic, Bally, IGT, Konami, WMS (Williams), also Cadillac Jack, Aruze, MultiMedia Games, Ainsworth, VGT & Novomatic
Dual cold cathode lamp assemblies for: Atronic 17" LCD & Koanmi 17" LCD, & WMS 19" LCD & Konami CCFL Edge-Lit Belly Glass
Triple cold cathode lamp assemblies for: WMS 17" and 18" LCDs

For IGT
#8500 - Single cold cathode lamp assembly for IGT 6.2 inch LCD
#8610- Protective Mylar sheet W/ copper tape attached for 6.2" Hitachi LCD in IGT NexGen
#8570-6.2 inch Hitachi LCD #TX16D11VM2CAA with 4 wire touch screen for IGT NexGen

FOR BALLY
#8650 - Single cold cathode lamp assembly for Bally IView player tracking system 6.2 inch "IDW" LCD
#8680 -- Single cold cathode lamp assembly for Bally IView player tracking system 6.2 inch "IDW" LCD
#9890 – 5 wire touch screen for Bally IView 6.2 inch Hitachi LCD
#8950- 5 wire touch screen kit for Bally Iview 6.2 inch "IDW" LCD
#1240 – 6.2" Hitachi LCD $TX16D11VM2CCA

FOR KONAMI
#9780-"L" shape cold cathode lamp assembly for 7 inch AU Optronics LCD
#8550 – "U" shape cold cathode lamp assembly for 7 inch Sharp LCD
#1010 –7 inch AU Optronics LCD #C070VW02 for bonus screen
#1250 - 7 inch Sharp LCD #LQ070T3AG02 for bonus screen

FOR WMS (Williams)
#8520- Triple cold cathode lamp assembly for WMS slot machine with an 18" LCD monitor
#9300- Single RAW cold cathode lamp for WMS games with 19 inch LCD monitor
#8490 - 6.4" "LG" LCD #LB064V02 for bonus screen (does **NOT** come with touch screen)

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of the software we use. For these reasons, correct values for the contents of this EEPROM are very important for the future, trouble-free operation of an LCD monitor.

Every time you turn it on, the microcontroller reads the contents of this memory and, if it finds any content, retrieves the parameters used to initialize the image processor, regardless of whether they are correct or not. Most of the software makers do not address EEPROM content and therefore do not control the content of the EEPROM checksum.

This explanation brings us to the heart of the problem when, after exchanging the old electrolytic capacitors in the DC-DC converter section (by far the most common faults) the monitor is still not working properly. The reason is that the old capacitor DC-DC converter causes voltage fluctuations to 5V microcontroller. Voltage can vary between 3-6V at frequencies up to several hundred kHz according to the state of the damaged capacitor. This leads to the generation of cyclic signal for the microcontroller reset. Moreover, the very old capacitor in the reset circuit causes a shortening of the length of the reset to unacceptable levels, which eventually causes a false start the microcontroller. This false start may lead to incorrect implementation of the program. It may also overwrite the contents of user EEPROM to random or meaningless values.

This leads to a condition

Figure 3

Figure 4

Figure 5

where, after replacing the old electrolytic capacitors, the LCD monitor still does not have proper function. When you turn on the monitor, the microcontroller reads the EEPROM incorrect values (which is meaningless data) and either no picture is displayed or the image appears damaged but there is nothing wrong with either the LCD panel or the VGA signal.

I recommend the replacement of the capacitors in the DC-DC converters and replacement of the capacitor(s) in the reset circuit(if used and capacitors in the voltage regulator circuits for 3.3 V and 1.8 V for the video processor.

To avoid misunderstandings of the fault symptoms this monitor, I recommend before attempting to change the contents of EEPROM that you do the following:

- Check all voltages: 12V, 5V, 3.3 V and 1.8 V at best in completely connected monitor.
- Try to choose the user monitor menu "factory reset" or similarly named eg. "Recall" or "default values."

Removal or Modification of EEPROM Memory Contents

There are many ways to change the contents of the EEPROM.

If you do not have a spare A/D board and also you do not have file content of the memory then:
- buy a new EEPROM memory of the same type, eg. 24C16. As it is empty, after replacing this EEPROM, the first time you turn on the microcontroller, it will restore the correct contents in to new EEPROM.
- Remove any old EEPROM memory of the same type from any old board, erase it on the chip programmer (all at FFH values) and solder this EEPROM in the A/D board to fix.

A simple way to remove/desolder the serial I2C EEPROM 24xxx or any 8 pin smd integrated circuits off a board is shown in figure 6.

Removing PLCC microcontroller and PLCC FlashROM and using special equipment in SMD to DIP in chip programmer is shown
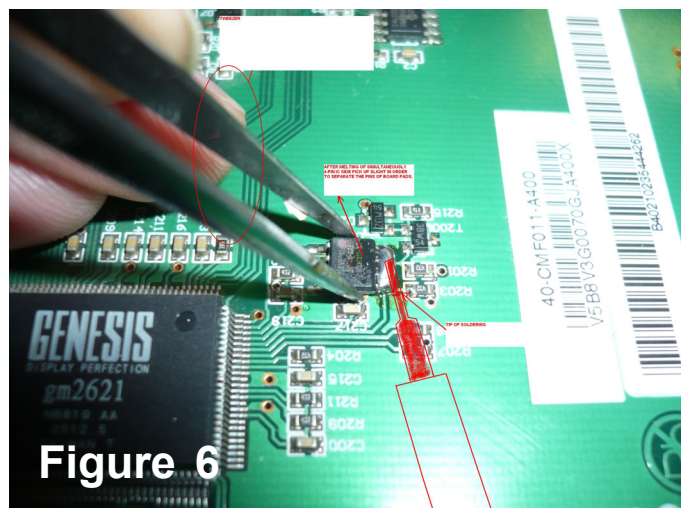
Figure 6
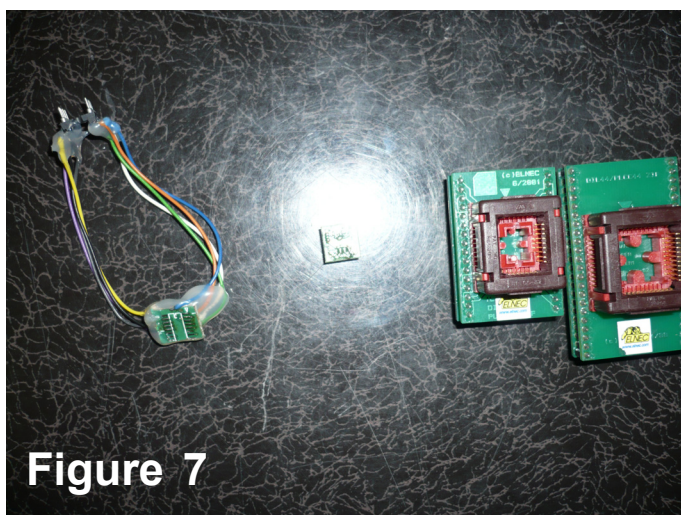
Figure 7
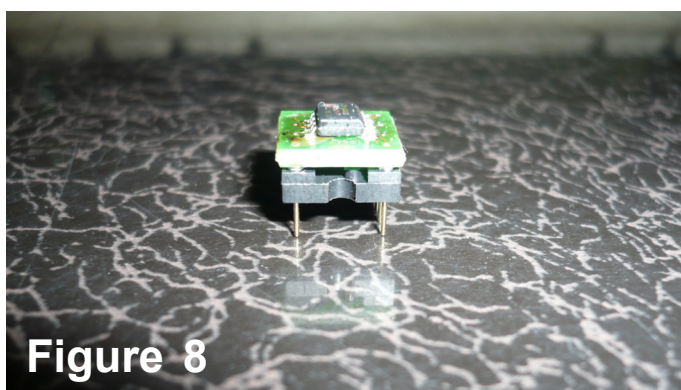
Figure 8
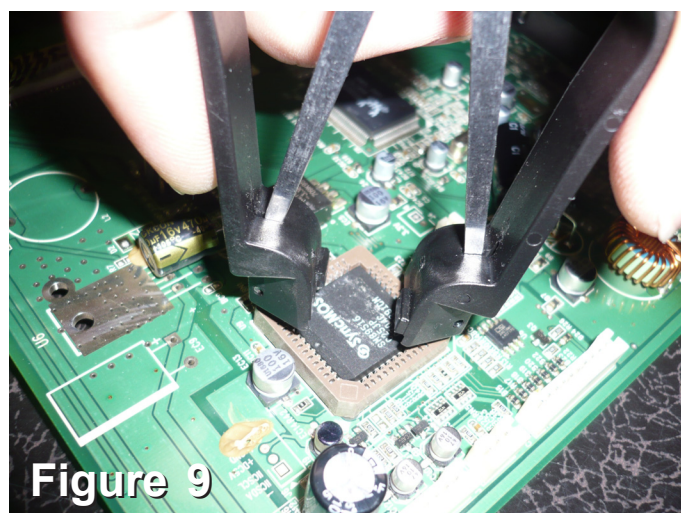
Figure 9

Figure 10

Figure 11

in Figures 7,8,9,10 and 11.

For the future, it is advisable to back up the content for each type of A/D board so that you can reuse and return the EEPROM to the correct content.

Some A/D boards use a configuration where the signal processor and the microcontroller are both on a single Chip. These types of hardware largely use external program memory stored in FlashROM and also external EEPROM.
If you can not find the EEPROM in your A/D board or find there is only FlashROM memory, then it is normal that the memory is divided within to "program area" and "EEPROM area." In these cases, I do not recommend to clear contents FlashROM memory precursor without backup. I suggest you first create a complete copy of a good A/D before proceeding with the next attempt.

- Heno Kollar
hkollar@slot-techs.com

December 2012

Quick & Simple Repairs #91

By Pat Porath

Ticket Printer LED Tester for Bezels

Not long ago, we did a conversion on a bank of Bally Alfa games in which the GEN 1 printers wouldn't work with the new game software. Ithaca Epic 950 printers were installed as replacements. Along with the printers, new printer LED bezels were needed so they were ordered too. Everything was installed and worked well. Now I have some extra printer LED boards for spares to go through and test to make sure they all work properly or need to be repaired. A few were tested on the printer bench and didn't work. I was using a GEN 2 printer so the boards should have worked but I didn't know why they didn't. A few more were tested and failed. A co-worker brought a few boards to our other shop where they tested fine when connecting them up to 24VDC directly. I then took a LED board directly to a game and sure enough, it tested good in the game. My test unit had a failure, not the boards! It worked before, why not now? As I later found out, it was a bad printer.

However, I wanted my own way to test the printer bezel LED on the printer bench so here is what was done. A 24VDC power supply was located, an Ithaca 950 type Molex connector, a small black connector out of a "parted out" GEN 2 printer, and some wire. Since the power supply had two of the same color output voltages I wasn't sure which was the hot wire and which was the ground. A DMM can be used to determine polarity. In this case, I grabbed a polarized LED lamp to do a quick polarity check. On the printer bezel LED board, the light color is positive and the darker color is negative. It also showed right on the board which was which too. Next, both connectors were hooked up to the power supply as shown in the picture. They were heat shrinked and now ready for the test. I connected one LED board to the one connector and the other type to the other connector. When voltage was applied, they both lit up great! Making a simple LED board tester did the trick.

Atronic e-motion Wouldn't Boot Up

On an Atronic e-motion "Doggy Cash" progressive game, it was trying to reboot itself but didn't boot up all the way. The main power was turned off then back on again without success. It would only boot part way then restart again. Next, the game was turned off and both the main processor board and the COM board were reseated. Once again it started to boot up, only this time it went further. As I waited for it to restart itself the game finally booted up all the way and was ready for play. It looked like reseating the boards did the trick.

EPIC 950 type power connector

24 VDC

GEN 2 type power connector

Bally type printer bezel LED boards
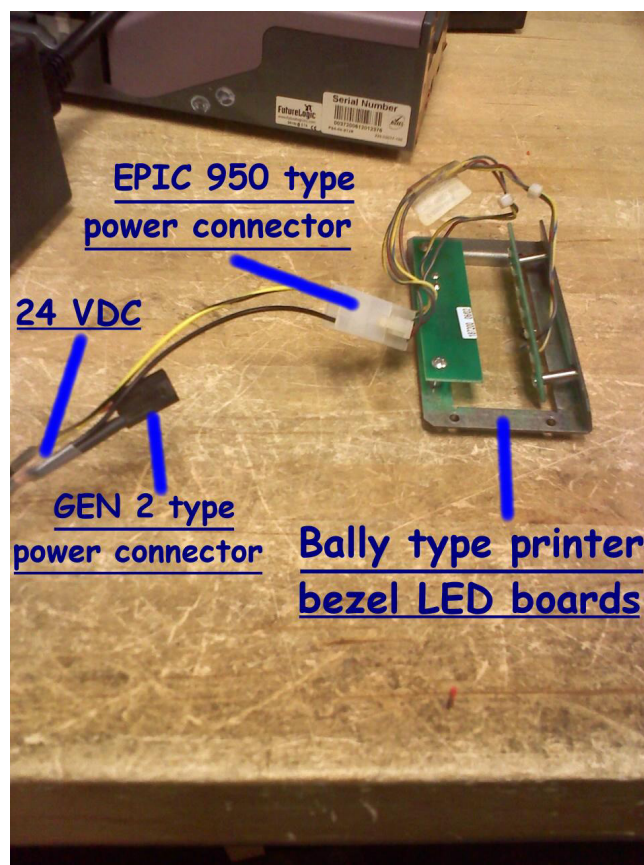
Older Konami Slant Top "CD Read Error"

While a customer was in a bonus, I was told the game "froze up" so the game was power cycled. In the first part of startup, right on the screen it showed "CD read error." Hoping the disk only needed to be cleaned, I removed it for inspection. Sure enough it was dusty. I have seen worse though. Maybe the disk was only dusty or maybe the CD drive needed to be replaced? I had a customer waiting for her bonus so I had to think of something fast. The quickest and easiest would be to wipe the disk off with a cloth and hope for the best. A quick wipe of the CD did not work. Now what? I cleaned the disk again and also very carefully wiped off the LASER diode which is in the CD drive. Power was turned back on once again. This time the indicator light on the outside of the CD drive started to flash rapidly. When the light flashes slowly, more than likely it isn't reading a disk. When it flashes rapidly, there is a very good chance that the disk is being read properly. Also on the startup screen of the game "CD check OK" appeared which meant the game did in fact read the disk. After the game fully loaded, the customer continued right where she left off in her bonus round. A quick cleaning of the CD along with quickly wiping the dust off of the optic in the CD drive fixed the problem.

IGT S2000 Bonus Reel Strip Problem

This particular game has the standard three reels with an additional fourth bonus reel but the fourth one wasn't paying on the pay line. By looking at the reel strips I could tell they must have been recently replaced because all four were nice and shiny, not faded at all. Since the game was an older one, the strips probably would have faded a bit. My personal theory was the reel strips were replaced but the fourth reel wasn't tested. I was told the reel strip "paid" off the line but not when a winning symbol was on the line. Luckily (and maybe a bit unusual) the customer playing the game was TO-TALLY cool and calm about it. He cashed out and played a game similar to it.

Right away I removed the fourth reel and looked for the small square notch that is usually molded into the reel basket assembly. Unfortunately I could not locate the notch on this one, there were only some numbers on it. Maybe the starting point of the reel strip needed to be at the number zero or one? Not being really sure, I talked to the employee that was dealing with the customer to see how far off it was. To me it sounded like the reel strip was attached to the reel basket "one step off." First off, I started to take off the reel strip and move it on the basket so it was secure one step from its previous position. The reel assembly was put back in the game, then power

turned back ON. After it booted up, I accessed diagnostics to do a reel strip test. A regular reel strip test didn't affect the bonus reel at all so I couldn't tell if it was on correctly or not. I exited "reel strip test" and found "bonus reel strip test." Bingo! That's what I was looking for! Sure enough, each of the different stops were tested. The VFD display showed what was supposed to be on the pay line and the symbols landed on the fourth pay line perfectly. With confidence I closed up the slot door. The game was fixed.

IGT AVP 3.5 Communication Error

The communication problem was between the game, the SIB board, the Mystery Progressive system, or everything. It seemed like every other day, I would have to reboot the SIB board in the game, then reset the error on the progressive computer. It would last a day or two then go into a communication error once again. DIP switches and jumpers were checked on the SIB along with a quick look at the game option software. Nothing looked out of place. Finally I decided it was time to find out what the deal was. One of the first things I did was move the IGT COM board from COM channel 2 to channel 3 on the game mother board. The next morning it had an error once again. This time a replacement SIB board was installed (the mystery progressive board in the game). Yet again an error occurred. A replacement IGT COM board was installed on the

game mother board, which didn't cure the communication problem either. Even the main processor board on the game was reseated.

What was left? What about taking a closer look at game option settings? Both the problem game and a game next door were opened to compare "protocol settings." Under "protocol control setup" I noticed a difference between the two game settings. One showed "legacy bonusing" set at "none" and the known working game showed "legacy bonusing" set at "serial SAS 2." Maybe this incorrect setting was the problem the whole time? "Key 7" was inserted in the game to allow the option to be changed. Now all of the protocol options matched. Over a week has gone by and I haven't seen or heard of a communication problem from that game yet. It looks like an incorrect setting in the "protocol control setup" area was causing a problem the whole time.

JCM Ticket Printer Feeding Tickets

I was asked if I knew a repair trick to fix a JCM ticket printer that kep feeding out tickets continuously.

"Well as a matter of fact I do know a trick, I replied. The 'feed ticket button' is stuck in the downward, ON position. Simply take a small pair of pliers and gently move the button upward and downward a few times to free it up."

Problem solved. If the button still feels sticky, try a quick spray of contact cleaner (with power off of course). If the white cap falls off the feed button, it's OK; the button will still function.

Atronic e-motion "Presentation Error" on the Screen

What is a "presentation error" on an Atronic e-motion game? The problem was simply a stuck ticket in
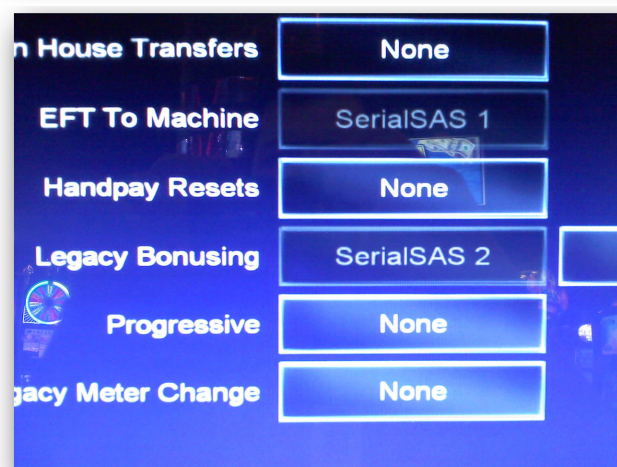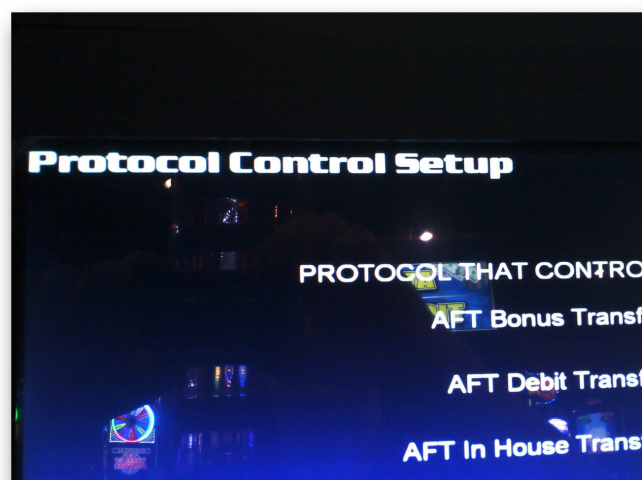
the ticket printer. I first tried a key reset and then a reboot but neither worked. Then, I took a look at the ticket printer. Sure enough, there sat a ticket jammed in the printer. After it was removed and the reset key turned, the error cleared.

"Mikohn Mystery Progressive" Meters Frozen

We have banks of IGT S2000s that have a "Mikohn Mystery Progressive" system connected to them (a total of 40 games). While briefly chatting with a slot attendant, the individual pointed to a game in which the second level progressive meter was mostly frozen. The other two meters were totally frozen; they were not incrementing like the other games. I have never seen an electronic progressive meter partially frozen before. If anyone remembers the old "hard meter days" where games such as "Universal" used hard meters, sometimes one of the meters would partially freeze up. The last digit (farthest to the right) would only "click" but not increment to the next digit, somewhat stuck in between digits. But in this case the meter is totally electronic and wouldn't "flip" to the next number. In other words, the progressive meters were stuck.

To resolve the problem I turned off the game power then disconnected the 120 VAC power cable which connects to the game so ALL of the power was disconnected, including the Mikohn progressive board (Slot Interface Board or SIB, sometimes also called a "SMIB" for Slot Machine Interface Board. I waited around a minute then reconnected the main power cable. The top monitor progressive box started to boot up along with the SIB. Next, main game power was turned on. After everything was fully booted, all three of the progressive meters took off incrementing fast. When the progressive numbers got closer to the other games they started slowing down, then they caught up to the other games. A reboot of main power to the game, SIB, and top progressive box in the game did the trick.

Pat Porath
pporath@slot-techs.com

December 2012

Slot Tech Event-TechFest 26 MotorCity Casino, Detroit, MI

Below: Three-time TechFest Alumus Michelle Dedmon enjoys the wonderful buffet lunch.

Above: First-time TechFest presenter Paul Paroff (Esterline) presented a look at the WMS button assembly.
l: Dan Petersen-JCM
r: David Oldham-Suzo-Happ
below right: Brett Bruce-Ceronix
below: Russ Wige-Transact Technologies and the TechFest 26 class.

A Fault Too Far

By James Borg

The phone rings, and an unfamiliar voice at the other end asks you to have a look at something as it's not working. Next second, the voice hangs up on you before giving you a chance to ask what the something that's not working properly is. It could be anything from a simple button to a complete slot machine. What is the first thing you do? What is your first reaction? Where does your mind go? What tools or parts do you take with you? Are you up to do the job, or shall you wait for somebody who knows the job inside-out, so you can tackle the problem together? Most times, there is nobody around when you need a helping-hand, and reality can be cruel. Sadly, the bottom line is, you've got to roll up your sleeves and, with a certain amount of hesitation and apprehension, go for it or die trying.

That said, it's the easiest of the process. The tip of the iceberg if you wish. The second part of the process is keeping your cool. Ideally, you follow the sacred rule of the three 'C's. You have to keep Cool, Calm, and Collected, not in any essential order. Applying this rule helps you tremendously to focus on the problem in hand.

Faults come in various forms and sizes, and span as wide as the distant horizon when viewed from the rocks by the calm sea. (Editor's Note: Mr. Borg is a citizen of the tiny island of Malta so will forgive him his maritime references from time to time). Even though some are stock ones, other faults make your hair go on end when trying to tackle them. The 'hair on the end bit' happens to the best of the best so a newbie need not feel inadequate or attempt suicide when faced
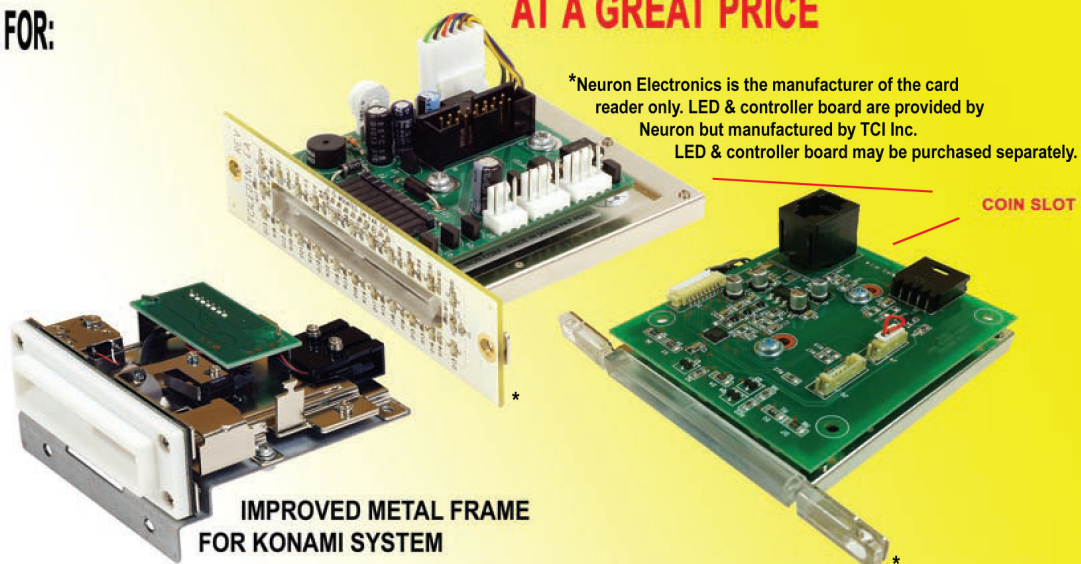
with this situation. The most important issue is to try and dissect the problem one step at a time, piece by piece. No piece of equipment out there is a whole. There are always modules, units, sections, boards, and a plethora of peripherals that you can eliminate in the process to trace down a problem. Depending on the nature of the fault, eliminating some of these 'modules' blindly, can make the situation even worse, so one has to be careful which parts to pull out during the fault finding process.

The number of problems I've come across are too numerous to mention but nothing takes the biscuit more so than the intermittent cases. Faults of this nature are the nightmare of any technician. You think you've traced the fault, you think you've found and eliminated the gremlin, and you think nothing can stand in your way. You suddenly grow taller and the stars are within reach so you root out a champagne bottle and invite all your friends over for a party to celebrate what a brilliant technician you are. You're so good, you even manage to impress yourself. However, as it would have it, the next day another report is filed. The same problem has appeared again. This hits you like a high-speed train travelling at maximum speed. Your facial features change, you age years in minutes, your hair starts to go white and drop off, your knees start to shake and

you lose your speech just before your mind blows out through your ears.

Unfortunately, the life of a technician can be a tough and a lonely one, especially if you are the only technician around. Just because your title is that of a technician and you enjoy your job tremendously, you're expected to locate faults in seconds and perform miracles at the click of a finger. There can never be an excuse. Spare parts are always available, equipment is all ready and calibrated so what's the big deal? You're the technician, you find the problem, you figure it out. Ouch!

It takes a special breed of people to carry out certain jobs. With the passage of time, I realized that it takes a technician to understand a technician. They speak a different kind of language from everybody else. Some caring person even wrote 'The Dictionary of Electronics', to help 'all the others' try to understand some phrases and jargon technicians communicate with. To the normal person in the street, most of the conversation sounds . . . Klingon? Time and space permitting, I'll elaborate a bit more on these alien phrases later on.

That's the introduction over and done with. Now for the nitty-gritty, the scary bit, the bit you're supposed to be paid for to do, the bit that keeps you awake at night and makes you chew

your fingernails to the bone.

In a typical example, which is quite common, you're faced with a DEAD unit. For many, this might be an easy one. A blown fuse? A mains cable pulled out? A faulty switch? No big deal, surely. WRONG! Beware, a dead creature can be more dangerous than a live one. Just describing something being dead, as dead goes, is of little help to the technician undertaking the repair job. You'd like to find out how it died, if it was a slow death, if a resurrection ever took place, if it ever came to life when the machine was switched on after hours in the dark, if it went out with a bang or if it smoked, if it this or if it that. The list can be quite long.

Why ask so many questions, since dead is D-E-A-D, right? WRONG again! How the end of the line came to be can be of the utmost importance. A technician takes the role of a forensics expert gathering all the evidence, all the clues, then piecing them all together to form a big picture. That picture is what you will be working on to start tackling your fault. You need to ask as many of the questions mentioned above as you can (and more) so you can at least start tackling the fault from the proper angle. Spending or wasting hours on the wrong side of things can frustrate even the elite of the dedicated staff in this delicate field of technicali-

ties. I'm going to go over the different angles a piece of equipment can go wrong, and your approach.

A Slow Death:

This type of death is not very common, but it happens. A typical case that comes to mind is the gradual loss of brightness and quality of a CRT screen. Although all manufacturing has gone over to LCD monitors, there are still a lot of CRT monitors in the field that are likely close to or already in the process of dying. The deterioration process could take weeks, or even months. Many CRTs tend to lose their oomph after years and years of faithful service. When they will eventually fade out so badly, they become next to useless. In days gone by, there was a process applied, known as rejuvination. As the name implies, it rejuvinates the tube (see Slot Tech Magazine August 2001). However, If the CRT isn't made of the tough stuff, it can be killed, permanently. On the other hand, if it works, then there will be a significant improvement in the picture but only for a limited period.

The rejuvination process is basically forcing the CRT to its very limits by means of a specialized piece of equipment called, surprise surprise: a rejuvinator. This involves blasting the cathodes and the heaters to their extremes. If the CRT is old and past the point of

no return then no amount of rejuvination will bring it back. Since there's no tangible way to keep track of how many hours the monitor has worked, nobody can be sure for how long it will carry on working properly. However. there are tell-tale signs to look out for, a bit like wrinkles on a face, to give you a rough idea of what you're dealing with.

Typically, a good CRT should be sharply focused all over the entire screen with all the three colors bright and breezy, not dull and hazy. The brightness and contrast should respond fine and set at around mid range. Increasing the

brightness, the contrast and the colors to their maximum, should still leave you with a good picture with no signs of picture smearing or tearing to one side.

Armed with the information above, should the picture start to fade out on you, you now have a pretty good idea if it's the CRT itself which has reached its end or if something external to it is making it behave the way it is and your CRT is still fine.
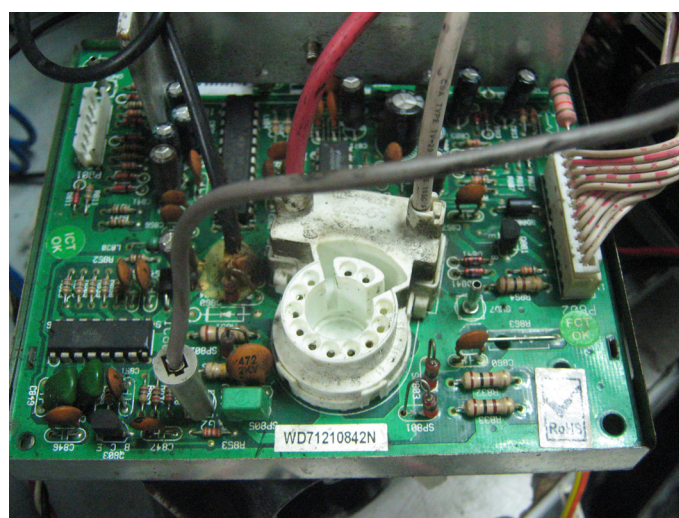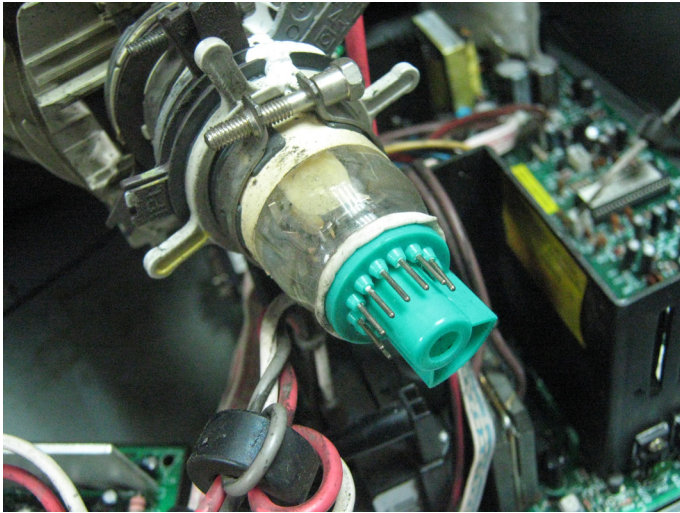
A dark picture can easily be the result of low voltage reaching the heater pins on the CRT, although it's not that common an occurance. Cleaning the CRT socket might help, in the eventuality that a substantial amount of oxide or some other nasty contact-inhibiting-agent has made its way into it.

Two words of warning.

SAFETY FIRST.

In simple terms, before poking and prodding inside a monitor, make sure the mains plug is pulled out. Just to make sure nobody plugs you back in when your back is turned, leave the plug next to you and actually look for it when starting to work on the monitor.

Another word of warning. Even though you have personally pulled out the mains plug and the monitor is 'safe' to handle, it can still give you a nasty kick. There are specific areas where a charge is retained. This can be in the order of hundreds of volts or even

thousands. In other words, don't touch anything inside, blindly. And try not to drop screws or other metal bits inside; that includes the screwdriver itself.

Removing the neck board is no big deal, as long as caution is exercised. Just pull the board out gently and straight. Don't wedge it sideways or apply any particular force to it. If it is really difficult to pull out, there could be something anchoring it to the tube's neck. The CRT won't break if handled gently but hitting it with a hammer doesn't qualify as 'gently.' In some cases, the neck board is glued to the base of the tube with silicone rubber. This is applied so the neck board won't come out of its seating should the monitor be moved about a great deal. In some models, the CRT neck board is actually clamped to the tube's neck by a round metal bracket, fastened by means of a screw.

In certain high-end monitors, the CRT neck board will be shielded to such an extent that you won't even

be able to see the components or the solder-side of the CRT socket. You'll have to remove some of these shields, known as a Faraday Cage, to be able to access the components and the print. Caution is also recommended here since the shielding can be quite sharp and slashing a finger or two is quite easily done. The cage tags might need quite a bit of heating to melt the solder holding them to each other.

If after a visual and, perhaps, spraying a bit of contact cleaner in the CRT neck board's socket, the picture is still weak, you'll have to dig a bit deeper. A more realistic approach is to turn your sights towards a power supply failure or even a flyback transformer problem.

Heaters normally run at 6.3V. This can either be DC or AC. DC is pretty straightforward to measure using a trusty multi-meter. If it's AC, chances are you won't see an exactly perfect reading using the same trusty multi-meter. Reason being is that the heater would be

fed off a tap from the flyback transformer which is working at over 15kHz. An el-cheapo meter is really looking for a 60 Hz sine wave and may not respond properly to the high frequency heater power. Try measuring the AC heater voltage on a working monitor and see how your meter responds, then you will know.

Focusing on the DC side of things, which are more common, the DC on the heaters should be DC, and only DC. In other words, there should be no AC presence at all. Normally, the heater is fed off a secondary tapping from the power supply's switched mode transformer. In its simplest form, a secondary winding would be rectified by a diode, and filtered by a capacitor. Should you measure the voltage across the heaters with a multimeter (typically pins 9 & 10, the two pins at the top of the arc of pins that are the CRT connections) and the DC level is low, just for kicks, turn the meter to read AC, and measure that as well. When I say the DC level being low, I'm talking about 4 to 5 volts, instead of the proper 6.3V. The AC reading could be in the region of 2 volts, roughly. In such cases, you have something wrong there. To check this out properly, I do suggest using an oscilloscope as that will easily show the presence of an AC voltage superimposed on the DC line.

Nine out of ten times, your filter capacitor has done a runner and lost its capacitive properties. In the circuit above, the value of this capacitor is 470uF at 16V, designated as C123. In worst case scenarios, I've even measured the capacity of this component to read as low as a 100uF. The result would be a messed-up DC voltage reaching the heater, resulting in a poor picture all round. Just replacing this capacitor should solve your problem.

So far, I've only come across a single case where the heaters went open circuit. Please note, this has nothing to do with a slow death, but simply for the sake of mentioning it. The voltage feeding them was next to perfect and yet no picture and no glowing heaters were to be seen. I even

December 2012

turned out the lights in the workshop just to make sure but no golden glow was visible anywhere. I had to check several times before it actually sank in. That was strange, as the heater element is very robust and is capable of withstanding a great deal of punishment. Having said that, there is always a weak link and with heaters, the time when they are the most susceptable to damage is when they are hot. At high temperatures, they become more susceptable shock. A substantial knock on the tube's neck can easily get the heater element to go open circuit. Hit the neck a bit harder and you'll break the tube. You'll know it's broken as you'll hear a loud hissssssssssss coming from it. If that happens, you

won't have to worry about the heater element any longer and you'll have to start looking for a replacement CRT. Something worth keeping in mind: When moving a monitor, best to always let it cool down, even for a few minutes.

Before finishing off this first part of the article, I'd also like to mention that if you really do have a weak CRT and the rejuvination process doesn't work, and you don't wish to invest in a new CRT for reasons of cost, then you can cheat a little bit. Please be warned: You'll be stressing the heaters somewhat. However, I've done this and it truly works.

If the 6.3V is perfect, you can increase this some-what. I stretched mine up to 7V and the difference it made was really impressive. What I did was by-pass a series resistor feeding the heater. I know this is naughty but at the time I didn't have anything to lose and luck was on my side. The monitor was still working fine the last time I looked.

In the next part of this article, I'll tackle slow death when it happens to a TFT screen. Till then, remember, SAFETY FIRST and of course, the ever faithful rule of the three Cs.

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