SLOT TECH MAGAZINE

Slot Machine Technology for the International Casino & Gaming Industry

December 2011

Mikohn Progressive Gaming Meter Fun

Quick & Simple Slot Machine Repairs

Oscilloscope Part 2

Slot Tech Magazine

$10.00

On the cover: Twilight Zone @ G2E 2011

December 2011

The Repair Dilemma

It's a dilemma that is faced daily in slot shops around the world: fix or replace? When is it better to replace a failed sub-assembly rather than (attempt to) repair it? See those parentheses? That's the rub! Unless it is a common repair where we are more-or-less certain of the failure mode and that we will be able to effect the repair quickly and at a reasonable cost for replacement parts and labor (don't forget that the casino actually pays you to work for them) when a tech opens a failed unit for the first time, there is not really any way to know how long it will take for diagnoses and repair or even if the repair attempt will be successful at all. It's a crap shoot which is, I suppose, ironically aprospos for a casino's repair shop.

A classic example is the power supply failure in this month's lead article, submitted by Chuck Lentine of Harrah's Casino in Chester, PA. In the end, the repair was effected by replacing a fan and a diode. The fan costs just seven bucks. The diode was actually expensive (for a diode) at around three dollars so we're talking about a sawbuck altogether. I am unaware of the time to diagnose and repair but from the description in the article, I believe that I could not possibly have done this in less than one hour and, to be honest, it would likely have taken more. I don't want to spoil your reading by discussing it further here.

So, including labor, the repair likely cost $40 or so, most of which was labor WITH NO GUARANTEE of success. TRC Electronics carries this power supply for $63 therefore, when you attempt to make the repair you are, in effect, gambling $23 against an hour or more of possibly wasted effort if the repair fails (and let's face it, we're not always successful-at least I am not). I suppose it depends on your skill level as a repair technician. As a component-level bench tech, I find it extremely difficult to "let go" of a repair project, especially when I am fairly certain that I am only looking for one bad part (as opposed to a "wipe-out" with a long path of destruction). The big unknown is how long it will take to locate a defective component that likely costs less than a dollar. If it's a specialty "slot machine" power supply (such as those made by SETEC), casinos really need to make an extra effort to repair them as they are expensive and unavailable on the open market. On the other hand, if an exact replacement supply is available at a reasonable price (or if regulations allow you to substitute the defective power supply for another type, such as in the case of signage or, perhaps, if the specifications simply call for an off-the-shelf computer supply) then it becomes a judgement call. You can handle it on a case-by-case basis or you can sit down and think out a strategy that works for your casino and include it in your SOPs.

Another factor to consider is just how busy you are. If you have time on your hands (Ha!) then repair becomes the attractive option. Although the casino does pay you X per hour, the payroll costs are fixed. If you repair the unit and don't buy a new one, you have saved the casino money with your repair, no matter how long it takes. Even if you have attempted but failed to make the repair, it's "no harm, no foul" if you have the time to make the attempt. However, you cannot (under any circumstances) allow customer service to suffer because you have your head stuck in a power supply on the bench. One minute to you is an eternity to a player waiting for machine service. If you're on the bench instead of walking the floor, how does that affect the customer experience?

If you're reading this, you and I both have survived 2011. Whew! Thanks for being a friend of Slot Tech Magazine. I appreciate your support. See you next year.

Randy Fromm

Randy Fromm - Publisher

Randy Fromm

Randy Fromm's
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Slot Tech Magazine is published monthly by
Slot Tech Magazine
1944 Falmouth Dr.
El Cajon, CA 92020-2827
tel.619.838.7111 fax.619.593.6132
e-mail editor@slot-techs.com
Visit the website at slot-techs.com

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Mikohn Progressive Gaming Meter Fun

By Chuck Lentine

On some banks of slot machines that have a progressive award, there is usually what we call a "progressive meter" somewhere on the individual machines or one large meter mounted in a fancy lighted display hanging over the machines. These come in many various designs and are sometimes custom made for a particular casino or game theme. This article is going to focus on a "Crazy Diamond" sign and meter manufactured by eGads! and Progressive Gaming. This sign is an expensive, heavy, and large overhead unit that spans the tops of ten machines. The model of the meter is ED-0502-24. It is a full color LED sign.

The problem with this particular unit started after a power failure on the floor. The progressive meter would just shut off and come back on after two minutes. A couple of slot techs rebooted it and it was fine for a few days. The main power feed and data lines were checked with no problems. The main 120VAC power comes up one of the sign poles via conduit and splits to feed the fluorescent lamps, neon power supplies, LED power supplies, and the meter itself. The data line is just a regular Cat5 jumper cable coming from a splitter box in one of the machine bases and goes up another pole directly into the meter. Usually these meters are very robust and we have few issues with them. This went on for a while, as it would not go out while anyone was watching it.

Since the rest of the sign still remained lit, it was logical to rule out the main power feed. If the Cat5 cable was bad, normally these meters would display "C1" or "LINK DOWN."

The repaired unit with Harrah's slot tech Marc Lustman

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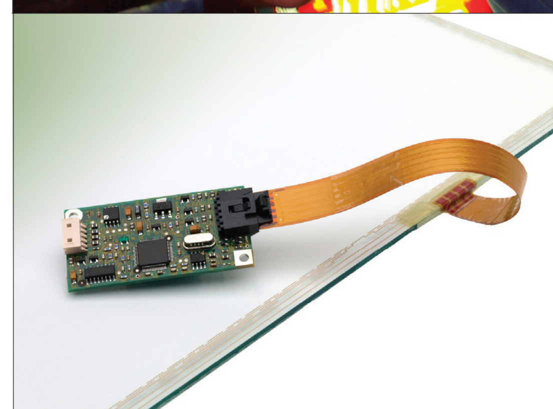

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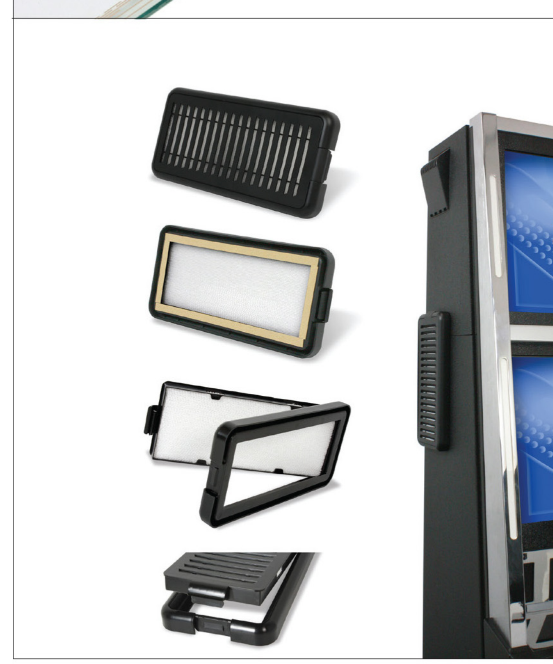

After watching the sign for about an hour, I caught it rebooting. The first thing I noticed was the first image displayed “Progressive Gaming” and a couple of progress bars running on the bottom. This means the main CPU that runs the meter was rebooting and the problem was inside the meter housing itself. Removing the meter from the rest of the sign looked to be fun and I said a few choice words to the sign and went to get tools and a helper. I mentioned earlier these are heavy so if you ever have to take one of these out please get yourself help from another tech or two, or three!

After removing two dozen screws, two face plates, and one bracket, the meter was exposed. All sorts of dirt and dust was hiding behind this thing. If you ever have the pleasure of doing this, bring a can of pressurized air with you, or you will be wearing it for the rest of your shift. The housing around the meter was a tiny bit smaller than the meter itself, so after starting with gently sliding, pulling, bending, twisting, and eventually a good hard yank (and more choice words) the meter popped out. You will notice on the back of the unit there a few different ports where data can be connected, so mark which one your particular cable is plugged into before you take it down. This is where help comes in as you should have two people up on ladders, not standing on the tops of the machines! The meter was then placed on a cart and sent back to the slot tech shop for a bath.

Once we got it back to the shop it was flipped over and all the screws were removed on the back to get inside it. Aside from being a little dusty, things looked good. These are well organized, modular units. There are two power supplies that run the unit. Each one supplies

+5VDC to half of each of the LED modules. One of the two power supplies also runs a small CPU mounted

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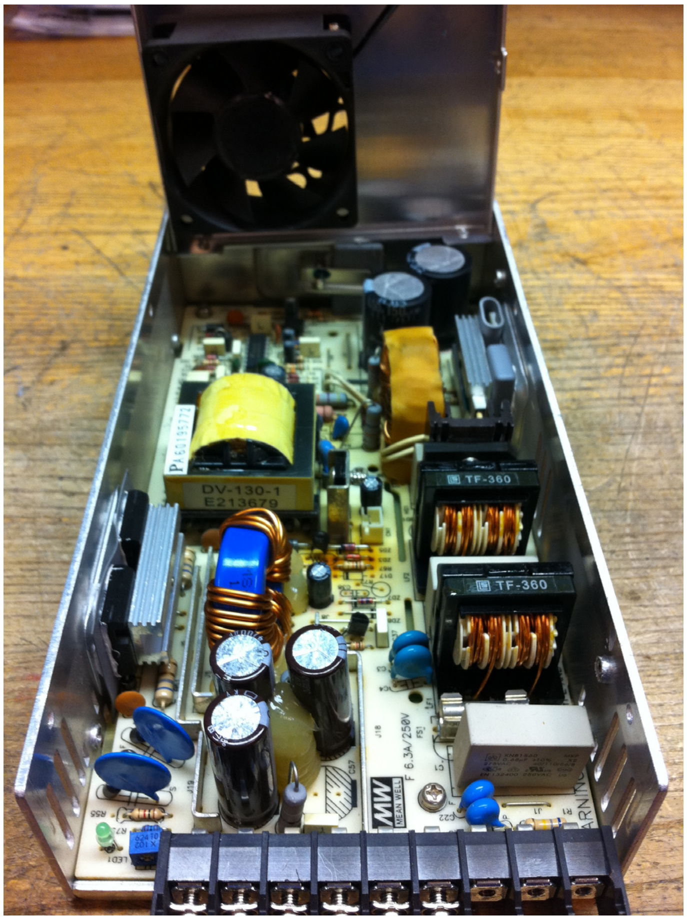

on the left side looking from the rear. (photo 006)

Power Supply Specs:
Mean Well SP-320-5 (5VDC)

When I plugged it in back at the shop, it booted up ok but started making a low humming noise not able to be heard on a noisy casino floor. One of the cooling fans in the power supply that runs the CPU was not turning. Now is the time to take both power supplies apart and clean them out and inspect the fans. The power supply that was humming got opened first. Inspecting the fan showed it had melted down and broken apart (not sure which happened first) causing a short.

Power Supply Fan Specs:
SUNON Maglev KDE1206PTV1 12VDC

After finding a replacement fan from Digikey, two new ones were installed in both power supplies and tested again. If one fan failed this badly, the other is probably not far behind melting down, so replace both while you are in there.

Smoke Test!

We put both power supplies back together and installed them back in the meter housing. Applied main power and watched the sign boot up. The new fans came up nicely. It actually got to “LINK DOWN” and it pooped out again! The first thing we grabbed was a multimeter and started checking voltages. The previously good power supply output was locked at +5VDC. The power supply output with the bad fan (and the one that powers the CPU) was wandering between +4.7 and +5.0VDC. I took the power supply out again for analysis. Could it possibly be a bad cap from the heat? They looked ok earlier, with no blown out tops.

I tested all the caps and they checked ok. The problem must be further down the line. One diode (D2) was found to be acting erratically. It is the largest diode in the power supply marked 4E2208. This

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Randy Fromm

Publisher-Slot Tech Magazine

crosses to an NTE577 general purpose switch. I replaced it and tested the output again, and it was a steady +5VDC. The power supply was installed back in the meter and left for stress test under load and monitored for an hour. The meter booted up and displayed “LINK DOWN” and held steady. I don’t have a data line in the shop to test, but as long as it remained powered up I was a happy camper!

Editor’s Note: I was surprised by this type of failure, resulting in the following e-mail exchange:

STM
I am surprised that the issue was not a fully shorted diode or bad electrolytics. Did you test the diode out of circuit? Did it have some sort of junction drop? Reverse leakage?
Randy

Reply
Chuck Lentine to RANDY

I guess you could call the diode a junction drop. Out of circuit it was reading 8.8 ohms while a new one reads ~1.3 ohms. In circuit it was all over the place. Odd for a diode (at least for us) either they work or go full short.

That's about the only interesting thing happening here in the past few months. We are installing Prism player tracking on all 3000 machines we have for the past month and will be doing it until early 2012. Maybe something neato will happen with it..

Chuck

We put the whole meter back together and let it stress in the shop for a few more hours. Once we were satisfied with the outcome, we carted the meter back on the floor to the sign and installed it. The data line was plugged back into it and the correct amount was now displayed on the meter. It has been happy for a couple of weeks now with no reboots.

Happy Holidays and a Safe New Year to all the slot techs around the world!

- Chuck Lentine
clentine@slot-techs.com

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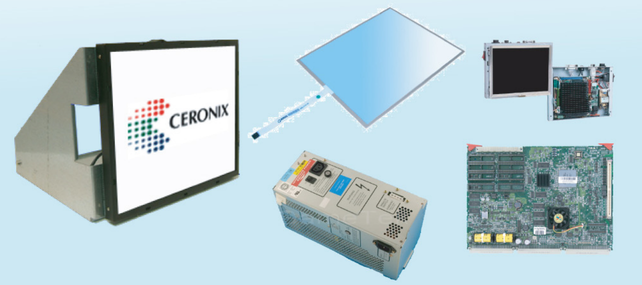

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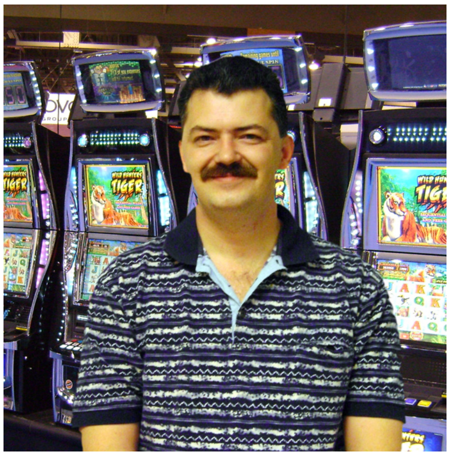
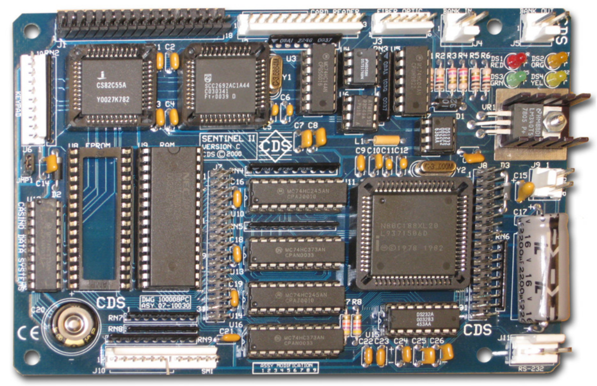
Quick & Simple Repairs #81

By Pat Porath



WMS Bluebird XD Power Problem

We recently converted five WMS XD games into "Alice in Wonderland" themes, which included replacement of the game top boxes. Hardware was replaced, software installed, they were tested, then released to the public. The next day one them was shut down. What the heck happened? All of them were running beautifully. I was told the game down had a power problem and that the power supply had been replaced without any success. A co-worker told me the game would power up properly then, within a few seconds, the game would lose power.



What was recently done to the game that could have possibly caused a problem? Well, since the top box had just been replaced the day before, why not check it out? Some of the connections were disconnected from the power supply, then the game power would remain up. The problem was narrowed down to a cable that was shorting out in the top box area. It was repaired and the game was back online.

WMS XD No Power to Sentinel

Photo courtesy Atlantis Resort Casino, Reno, NV

When I walked up to a bank of WMS XD games to help with conversions, I noticed one of the games didn't have an Oasis display. After the conversions were complete and it was near the time to test the games, I started to check out why the display wasn't working. At the Oasis display side, the cable that connected it to the Sentinel was checked and I made sure it was snug in place. Next, I checked the power connection on the Sentinel board which looked good too. The Oasis power supply cable that connects to the game for 120VAC looked good too. Maybe the power supply failed? After getting a spare from the shop and putting it into the game, there still wasn't any sign of 9vdc at the Sentinel at all. I even tried a different 120VAC socket that is just to the left of the main game LCD that didn't work either. Now the question was, where in the machine would the auxiliary power fuse be? Luckily my question was answered within a few minutes. We happened to have two WMS technicians on property at the moment and one of them showed me right where the

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fuse was located. Under a metal cover that covers part of the main game power supply, there are two fuses. One of them is for the internal auxiliary 120VAC power inside the game. It was a non-explosive (ceramic type) fuse so you couldn't see if it was bad by looking at it; a multi-meter would have to be used. It was faster to just toss in a new fuse. I really don't know why the fuse blew but after it was replaced, it was fine. Simply a blown fuse that is located in the main game power supply is why I did not have any 120VAC auxiliary power.

IGT AVP 3.0 "Board Monitor Tilt" Voltage Out of Range

I've run into "board monitor tilts" on AVPs before that were repaired by replacing the video card. If the video card cooling fan is OK, then it may have another problem. We recently had an AVP 3.0 that had a "board monitor tilt" voltage out of range, but it was only a "soft tilt" where the game did not lock up because of it. When the main slot door was open or when the reset key was used, the error would appear. A co-worker made a phone call and had a possible solution. Located about in the middle of the game, a small square board with a few connectors on it, is called a "power distribution board." Power the game off, disconnect all of the connectors from it (a couple of them go to the brain box) then simply reconnect them. Power up the game and the tilt should go away. From what I was told, the theory is the game monitors all of the game backup battery voltages to see if they are within acceptable range. When disconnecting the cables, a reset takes place. Of course if the tilt does appear again or appear again later in the shift, a battery could have gotten weak and may need to be replaced.

IGT "Game King" Set-Up Challenge

Well, it was a challenge to me anyway. We have a popular bank of Game Kings, muti-game, muti-denomination and one of them was shut off. Lately we have been doing pretty darn good holding ALL 1,335 games up and running (some days better than others). This particular game had been RAM cleared and needed to be setup and optioned. The interesting part, one Game King cabinet has 34 different games with six different denominations in it. No its not a typo. One Game King machine with 34 different games and six different denominations. The denominations included 1cent, 2 cent, 5 cent, 10 cent, 20 cent, and 25 cent. Some of the games were Texas Tea, Super 8 Line, Jacks or Better, Bonus Poker, Double Bonus Poker, Keno, Caveman Keno, and even Black Jack. I admit I was a little nervous. I don't consider myself much of a slot software guy or setup tech, even though I do it once in a great while. Luckily I had co-workers at my disposal if I had any questions, which I did. With the set up sheet in hand, I was ready to give it a whirl. The game was "key chipped" with number 28. I thought it would be number 37 but it wasn't. When key chip 37 was installed and the game was turned on, nothing appeared on the screen after a few seconds. So after the correct chip was used and the "boot chip" was put back in it was time to turn the game power back on. Now that I was in the "key chip" menu in which I

could enable games, I started down the list. Enable denomination, game, etc. and down the list I went. All of the sudden the 1 cent denomination wouldn't let me select it for Texas Tea. This was kind of weird. A bit further down the list of games to enable, another weird thing happened. I thought it was best to select the "clear all" option and start over. This time around when selecting and enabling games I would select the "save" option. After turning on five games or so I, would then press the "save" option then continue. This time I made it through the complete list like I was supposed to without any weird errors. The game was tested, the information verified and finally it was released for play.

Bally Monte Carlo Error Code 24 Would Not Clear

I received a complaint that a Bally Monte Carlo game (the Monte Carlo with a bonus wheel up top) wouldn't clear an error code 24. As a basic rule of slots, code 20s are coin-in errors, code 30s are hopper errors, code 40s are reel errors and so on. On this Bally, how could I have a coin-in error when the game was coinless? Part of the coin-in assembly was taken out for some reason or another so I put it back in. Still the error didn't clear. I wondered what would happen if I intentionally called a tilt. Would it clear? I gave the third reel a spin with my hand to cause a reel tilt. That error wouldn't clear either. The coin-in error cleared but the reel tilt remained. It kind of acted like one of the doors wasn't closed so it would reset. The belly door switch was checked along with the main door optic. Both appeared to be OK. Something that was a bit unusual was that the top light within the wheel wasn't lit up. I pressed on the upper door that is in front of it, then the light came on. Could this have been the problem all along? Simply the top door was open just enough to trip the switch to an OPEN state? After the top door

was locked properly (a lock is located on the left side and the right side) and the main slot door was closed a couple of times, the ma-

chine reset and the error cleared. The top door was open just enough to trip the switch into an OPEN state, not allowing the game to be reset by the main slot door. Another game back online.

Aristocrat Oasis "nCompass" What is it?

I recently heard of an item made by Aristocrat Oasis called "nCompass." Come to find out, it is the future of how a player uses his or her player card with the tracking system, such as Oasis. I guess I have to forget the OLD terminology such as CDS and Sentinel.

At first I was like what? nCompass who? What? Don't we have GPS now days? LOL. As I'm finding out and reading, the thing is pretty slick. From what I gather so far, Oasis nCompass is a device that can connect to the game and use part of the game video screen as the Oasis display. For example, a customer inserts their card, a sub screen pops up on the regular game screen and a customer uses the touch screen part of it to select items according to their player account. A demo video can be seen at youtube.com. Search 31734 aristocrat ncompass, or Google aristocrat ncompass. I've read that custom "Speed media" can be transmitted to individual players, along with video media. Now player info and in-house advertisements, promotions and many other things can display right on the game screen.

Ithaca 950 Repair

In my experience, the vast majority of the time the Ithaca 950s only need to be taken apart and cleaned. With this particular printer, a simple cleaning didn't do the trick. Motherboards were even swapped with a known good one but that didn't help either. The problem with the printer was that it wouldn't feed a ticket. When a ticket was inserted into the printer head area, nothing would happen. I took the printer apart once again for an inspection but nothing unusual was found.

About the only thing I could come up with was to swap the "top of form" sensor with a known good one. Luckily there was a spare already torn down for parts. After the replacement of the"top of form" sensor (the first optic the paper runs into) it was time to power up for a test. As soon as paper was inserted, the printer grabbed it right away. I held down the "feed button" for a moment and a self test ticket printed. Paper was fed into the printer numerous times, along with numerous self test tickets printed. Now the printer was ready to be tested in a game out on the gaming floor. It sure looked like the original sensor had failed. At a game on the floor, four cash out tickets printed perfectly. Without a doubt the "top of form" sensor was bad.

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The Oscilloscope-Part 2

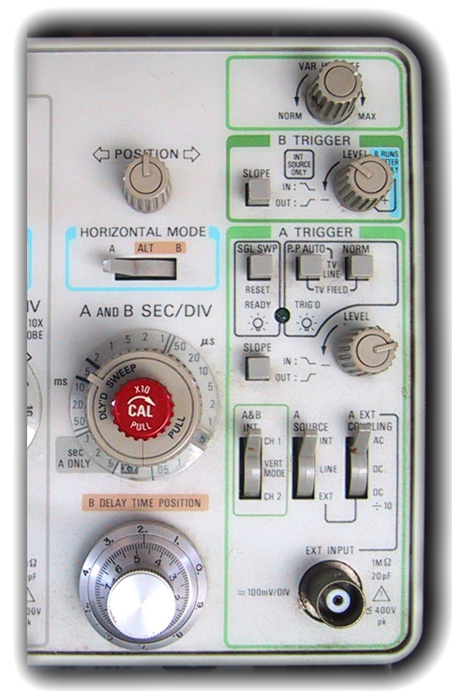
The Horizontal Section

The horizontal section of the oscilloscope is also known as the horizontal sweep or horizontal timebase. The graticule is divided into horizontal divisions just as it is divided into vertical divisions. The oscilloscope shows you "time" in the horizontal direction.

Just as the vertical control sets the volts/div, the horizontal control sets the seconds/div (see figure 1.) At its slowest setting of .5 sec/div, the beam takes a full 1/2 second to cross just one horizontal division on the graticule. With the scope set at its slowest sweep speed, we can clearly see how the electron beam in the scope's CRT scans across the screen from left to right. Remember, the oscilloscope draws a graph of voltage versus time. The vertical direction is the voltage; the horizontal direction is time.

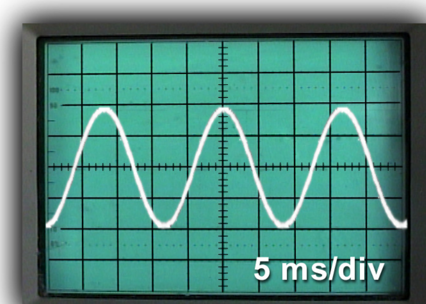
The next setting of the sweep speed is .2 sec/div. As we increase the speed of the sweep, we decrease the amount of time required for the beam to move a distance of 1 division. Now it takes just .2 sec for the moving beam to pass each division. The next step up is .1 sec/div.; just one-tenth of a second for each division. Since there are 10 horizontal divisions, it takes 1 second to complete the trip from the left side of the screen to the right. You may have noticed the 1/2/5 sequence we discussed when we looked at the vertical section.

As the speed of the horizontal sweep is increased, it eventually becomes so fast



that you can't even see it move across the screen. It just looks like a continuous line. At its fastest setting, it takes just .05 microsecond (that's 50 billionths of a second!) for each division.

Many of the measurements you make will be of "periodic" waveforms. That is to say, the waveform repeats itself after a specific period of time. In our 120 volt AC power we find a good example of a periodic waveform. We looked at this "sine wave" last month. Let's take a look at it again on the oscilloscope (see figure 2.)

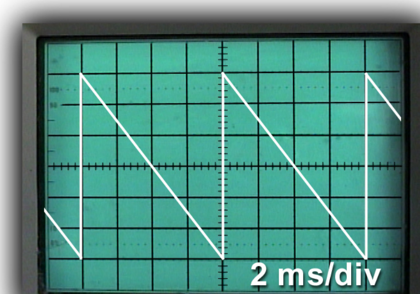


We can measure the "period" of the waveform by lining up an easily identifiable portion of the waveform with one of the vertical lines of the graticule and counting the number of divisions until the waveform repeats. Here we see the positive peak of the sine wave lined up with one of the vertical lines. The next positive peak comes a little more than 3 divisions away, at about 3.3 divisions. It's hard to be exact when you're measuring period on an oscilloscope. Sometimes it may help to try different horizontal timebase settings in an effort to get the waveform to line up on major divisions. However, the waveform should be reasonably spread out for the best possible accuracy.

But how much time is represented by each division? A quick check of the sec/div control shows that it's currently set at 5 ms/div. Multiplying 5 times 3.3 gives us a period of approximately 16.5 milliseconds. I happen to know that the period is actually 16.666666 milliseconds. This is an important number to remember because you will encounter it again and again in troubleshooting. 16.6 ms is the period of our AC power. When we use the oscilloscope to look at monitor circuits, the 16.6 ms period will come up again. The frequency of the monitor's vertical deflection circuit is the same as the frequency of our AC power; 60 Hertz.

I'm sure it comes as no surprise to anyone here that the frequency of our 120 volt AC power is 60 cycles per second or 60 hertz. What does that have to do with our 16.666666 ms period? How is period related to frequency? Okay all you math majors, here it comes . . . Frequency and period are inverse, reciprocal functions. What the hell am I talking about? Well, first of all it's something that you probably don't actually have to know about in our line of work so don't freak out. It's actually quite simple. period = 1/frequency and frequency = 1/period.

Let's take our 16.66666 ms period as an example. 1 / .016666666 = 60. There's our frequency. 60 cycles per second or 60 hertz. If we go the other way, 1/60 = .01666666 seconds or 16.6666666 milliseconds.



Let's figure out the period and frequencies of a few examples. Figure 3 shows a sawtooth waveform. Here, the waveform takes exactly 4 divisions to display one cycle. The horizontal timebase is set at 2 milliseconds per division. The period is 4 (divisions) times 2 (milliseconds) or 8 milliseconds. Dividing 1 by 8 milliseconds (1 / .008) gives us a frequency of 125 cycles per second or 125 hertz.

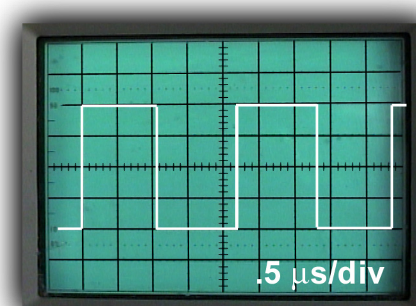


Figure 4 shows a square wave that repeats itself every 4.4 divisions. The sec/div control is set at .5 microseconds/division so the period is 2.2 microseconds. This translates into a frequency of 454,545.454545 hertz or approximately 454.5 kilohertz.

If you want to take a close look at a small piece of the displayed waveform, there is a knob in the center of the sec/div control called the X10 Magnifier. Pulling out the knob multiplies the horizontal sweep speed by a factor of 10. In other words, if the sec/div is set for 1 millisecond, pulling out the X10 Magnifier increases it to .1 millisecond/div. To use the X10 magnifier, center the portion of the waveform you want to see by using the horizontal position control, then pull out the knob.

This same knob also functions as a variable control in the same manner as the variable control for the vertical volts/div. Normally, this control will be in its locked, calibrated

position. Rotating the control will slow the sweep speed.

DO NOT USE THIS CONTROL TO TRY AND STABILIZE THE DISPLAY WHEN IT IS "RUNNING." This is a common mistake. There is another section of the oscilloscope that stabilizes the displayed waveform. It's called the "trigger" section and we'll get to it shortly.

Delayed Sweep

Here's a neat thing that the oscilloscope can do. Remember how we used the X10 magnifier to expand the waveform? There's another way that we can look at just a small portion of a waveform. It's called "delayed sweep." Delayed sweep is much more versatile than the simple magnification provided by the X10 magnifier.

Just as there are two vertical channels, there are two horizontal sweep generators as well. The main sweep generator is called "A"; the delayed sweep is called "B."

Horizontal Mode Switch

This three position switch controls which of the two sweep generators are active. Normally, this will be kept in the "A" position because "A" is the main sweep. Flipping to "alternate" mode engages the "B" sweep as well. This control may be labeled "A intensified by B" in some oscilloscopes because that's what it does. A small portion of the "A" sweep can be illuminated by the "B" sweep and displayed at the same time. I can select the portion of the waveform I want to display. The speed of the "B" sweep is selected by pulling out and turning the "A and B sec/div" clockwise.

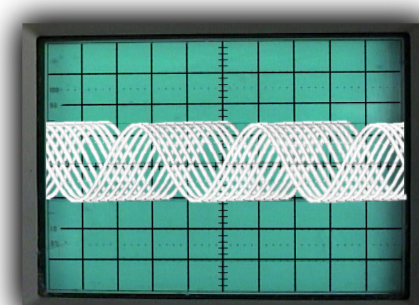
Not only can I select a tiny portion of the waveform to view with the delayed sweep but I can look at any part of the waveform with the "B delay time position" control. It's also called the "Vernier"; a technical term for a multi-turn potentiometer with a calibrated set of dials. By using the vernier, I can scan the entire length of the waveform and look at any portion of it in great detail. An A/B sweep separation control adjusts the spacing between the A and B traces.

Trigger

Now we come to the last section of the oscilloscope. It's also the least understood part of an oscilloscope. It's called the "trigger" section.

If you've ever done a videogame conversion, you know that there is a sync wire that connects the sync output of the logic board to the sync input of the monitor. The sync signal tells the monitor when to begin scanning. Without the sync signal, the picture would roll and shift; it would be completely useless!

For the oscilloscope to display a stable waveform as in figures 2, 3 or 4 it must synchronize itself to the incoming signal. That is, the horizontal sweep must begin at exactly the same point each time it traces across the screen. Otherwise, you'll see a display that is "running" (see figure 5.) The oscilloscope will display the waveform in a



different place during each pass of the beam.

Unlike the monitor (which has a separate sync signal input) the oscilloscope synchronizes by looking for periodic changes in the waveform. The trigger section of the oscilloscope looks for voltage changes in the incoming signal and triggers the horizontal sweep when it detects either a rising or a falling voltage (see figure 1.)

You can determine which "slope" or "edge" the oscilloscope will use with the slope selector. The "slope" control selects the "positive slope" (also known as the "leading edge" or "rising edge") of the waveform as the trigger when the button is out or the "negative slope" (also called the "falling edge" or "trailing edge") when the button is pushed in.

The "level" control is a very important little knob. The level control selects the point at which the triggering occurs. In other words, the level control selects where in the waveform the oscilloscope will look for a transition in voltage. It's usually a matter of slowly rotating the level control back and forth until the waveform stabilizes and you have a solid display. When the oscilloscope is triggered properly, the "triggered" LED will also light.

Trigger Mode Switches

There are three push-button switches that set the trigger mode for the A sweep. They are:

Auto Trigger - The "automatic trigger" allows the sweep to "free-run" regardless of whether or not there is a triggering signal applied. This setting also allows the oscilloscope to trigger properly on "TV lines"; the 63 microsecond time required to draw a single, horizontal line across the CRT of a monitor. You will use this setting the most.

Normal - The "normal" trigger setting will not show you a trace unless the oscilloscope is receiving an adequate trigger signal and the trigger level control is adjusted properly. If the oscilloscope isn't triggered, there will be no baseline. Use this setting when you want to precisely trigger the oscilloscope for maximum stability of the observed waveform. You will probably not use the normal setting too often.

TV field - Pressing in both AUTO and NORM buttons simultaneously allows the oscilloscope to trigger properly on "TV field" signals; the 16.66 millisecond time required to scan an entire field (one screen full of lines.)

Single Sweep Reset - To observe single events, the single sweep is used. When the oscilloscope triggers, it displays just one sweep, then stops. The sweep will not reset until you press the reset button. Then the oscilloscope will trigger on the next trigger pulse.

Ready Light - The ready light indicates that the single-sweep is reset and ready for the next trigger. Without this light, you wouldn't know if the oscilloscope was waiting for a pulse or if you missed it!

B level control and slope button - Remember that we actually have two horizontal sweep generators: A sweep and B sweep. The level control we just looked at is for the A sweep. There is a separate level control and

slope selector for the B sweep.

Variable Holdoff - Now we're getting complicated! The "variable holdoff" control can be used to increase the holdoff time between sweeps. It controls the amount of time the oscilloscope will wait for a good trigger signal (a change in voltage) before going ahead and triggering on its own. Like the level control, the variable holdoff is one of those controls that you just end up playing around with until the waveform stabilizes on the display.

A Source - And finally, you can select the source for the A sweep trigger signal. That is, you can select where the oscilloscope will look for its trigger signal. There are three choices: Internal, line and external.

Internal - The oscilloscope gets its trigger from the vertical inputs. Using the A&B Internal switch, you can select channel 1 or channel 2 as the input. You can even choose both inputs as the trigger source by using the "vertical mode" setting.

For example, when troubleshooting a monitor, you might connect channel 2 to the sync signal that's coming from the logic board or pattern generator, and select channel 2 as the source for the trigger. You're not going to view this signal, you're just going to use it as a trigger source. This way, the oscilloscope will maintain a solid trigger, regardless of what you're looking at with the other probe. Since everything but the power supply is synchronized with the sync signal, the display will remain locked in place no matter what signal you're probing.

Line - For working on linear power supplies, you might want to use the "line" setting. This selects the AC power source as the source of the trigger signal so that any 60 or 120 Hertz ripple will be perfectly synchronized with the trigger. You will probably not use this setting too often.

External - You can even couple an external trigger source to the oscilloscope. That is, you can use both vertical inputs (channels 1 & 2) to view two different signals, while triggering the oscilloscope on a third signal that's connected to the "external input" connector (see figure 1) The external input can be coupled to the oscilloscope in one of three ways:

AC - Signals above 60 Hertz are capacitively coupled to the input of the A trigger. Any DC in the incoming signal is blocked. Any signals below 60 hertz are attenuated. Attenuation refers to the lowering of an input voltage.

DC - The entire input is coupled to the A trigger circuit. This is good for triggering on low frequency signals.

DC :10 - External trigger input is attenuated by a factor of 10 before being passed to the A trigger circuit. For every 10 volts of input at the connector, 1 volt is passed to the A trigger circuit. This is useful when your trigger source is a high voltage. The maximum input voltage for the external trigger is 400 volts in this oscilloscope.

- STM

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Randy Fromm's
Slot Tech Magazine is published monthly by:
Slot Tech Magazine
1944 Falmouth Dr.
El Cajon, CA 92020-2827
tel.619.838.7111
fax.619.593.6132
e-mail editor@slot-techs.com

Subscription rates:

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