August, 2001

Slot Tech Editorial

Dear Randy,

One of my slot tech students brought me one of your magazines. Excellent! I attended one of your classes a couple of years ago. You came to Korea to teach a few of us slot techs. I enjoyed the class.

I have an article that may be if interest to you. It is about the incandescent lamps used in player panels of slot machines and video poker games. In Las Vegas, we are just beginning to see incandescent lamps being replaced by white LEDs.

The white LED has evolved into a plug-in replacement for the #86 and #73 bulbs used in the gaming industry. Sloan is the one manufacturer I'm familiar with. From what I get around internet, other LED manufacturers are following.

To get the LED to run off of the AC at those levels (6.5 VAC and 14 VAC), they build a bridge rectifier and a couple of resistors into the base of the LED. We have a few of them in our games. They glow a nice bluish-white, and look nice next to the yucky-yellow.

Good to see one of the good guys prosper!

Herschel Peeler

Hey, Herschel! What a rush to hear from you again. Thanks for your nice comment about Slot Tech Magazine and thanks for the interesting contribution (Readers, you will find Herschel's article on page 10). Our training mission in Korea was interesting to say the least.

Other contributions to this month's Slot Tech Magazine include Ken Locke's wonderful article on PAR sheets and virtual stops. I actually understand it now (sort of).

Pete Bachran has a wealth of floor tech experience. This month, he shares his repair techniques with keno light pens. I had no idea that the switch resistance was so critical to the proper operation of the pen.

Mike Thomas is our SDS expert. In part 2 of his discussion on SDS reports, he shows us how to find faulty bill validators without leaving the comfort of the computer chair!

I guess the most exciting news this month is the TechFest. If you haven't signed up yet (and it's not already full) you may want make plans to attend TechFest, 2001 in Las Vegas. The TechFest is a three day seminar program for slot techs only. For a preview of the show and an enrollment form, see page 18.

Randy Fromm

Frank Sutter draws to a conclusion his four part voyage of discovery through the treacherous waters of hopper repair beginning on page 24.

I can make a prediction that is guaranteed to come true. If you operate video slots, you eventually will have CRT failure. You can test and restore old, tired and worn out picture tubes with a remarkable piece of test equipment from Sencore called the CR7000 starting on page 26

What do you know about your players? NOTHING. So, how do you react when a guy that looks like he just fell off a turnip truck claims to have lost money in a machine? John Green has an insightful look at customer relations beginning on page 32.

Slot Tech Magazine writer Scott Reynolds is back with an update on his first few months as a slot tech. Read "On the Job" begin-ning on page 34. That's all for this month. See you at the TechFest!

Jtfyw^ft^.-Randy Fromm August,

Randy Fromm

Randy Fromm's
Slot Tech Magazine

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MEI Bill Acceptor

ZT Series 1000

ZT 1200

EASY TO USE

The Recognition and Transport Unit (RTU) and the Lockable Removable Cassette (LRC) can be removed from the front with one hand. The RTU fully opens for cleaning and electrically connects automatically when inserted.

An easily accessible toggle switch enables the operational mode to be changed to "test" or "set-up" mode.

HIGH, FOUR-WAY ACCEPTANCE

Satisfy customers by accepting bills of all conditions. Bills can be fed in any direction, face up or down.

BAR CODE CAPABILITY

Reliably accepts industry standard bar code coupons face up in both directions.

FUTURE FLEXIBILITY IN A FLASH

All US models accept $1, $2, $5, $10, $20, $50 and $100 bills. The ZT Series 1000 bill acceptor can be easily updated electronically to handle new currency designs.

RELIABLE / LOW MAINTENANCE

With the streamlined recognition system, sensors are embedded under the smooth plastic bill path and the magnetic head and pinch roller have been eliminated to dramatically reduce jams, debris buildup and the need for cleaning.

EXCEPTIONAL SECURITY

Through the use of multiple wavelength optical sensing and sophisticated data processing the ZT Series 1000 bill acceptor sets the standard for rejecting invalid bills. Optical cross-channel sensors examine the bill path for foreign objects such as clear tape or strings. The LRC triggers an automatic "lock out" when separated from the unit for added security.

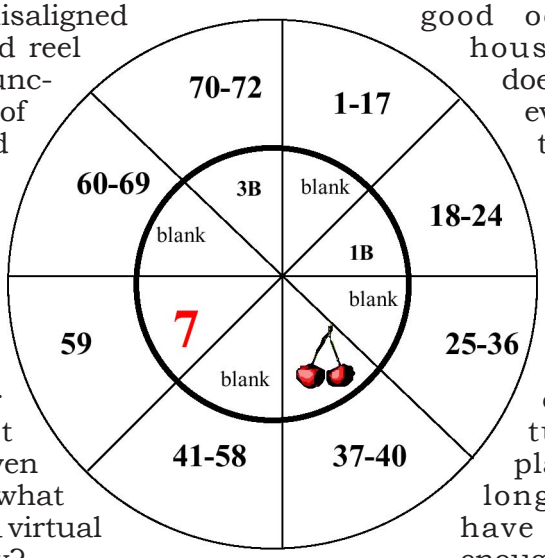
MEI®

Above PAR

By Ken Locke

"Malfunction Voids All Pays and Plays". Ah, yes, the last saving grace of casino and technician alike. If something goes awry, we don't lose a dime. Or do we?

Let's put that phrase to the test. Is a misaligned or misplaced reel strip a malfunction? Half of you said 'yes', half said 'no'. Next question, does a typical reel-spinner's processor know that reel strips even exist? And, what the heck is a virtual stop anyway?



"Hey, why does '7' get only one virtual?" (Figure 1)

This article is definitely going to separate the mechanics from the technicians. Can you, as 'the expert' decipher a Probability Accounting Report (PAR) and ensure what the glass says is what the reel strip says, is what the software says? These four elements must be accurate to ensure proper game play, and a reel strip and paytable test is essential to that end.

Let's start with reel strips. In short, these are the physical manifestations of the outcome of a random number generator. When the handle is pulled, three randomly selected numbers are created in the MPU and a signal is sent to each reel to interpret these numbers into a location on the reel strip.

Typically, reel strips contain 22 physical locations or stops, starting with a blank, then a symbol, then blank and so on. So let's do the math.

The possible number of outcomes with three reels with twenty-two stops is 22 X 22 X 22 = 10,648. Sounds like good odds in the house's favor, doesn't it? However a one in ten thousand shot at a prize of 25,000 credits doesn't sound like the kind of game I'd want in my casino. Eventually the player will hit long before we have taken in enough money offset the jackpot and thus making a tidy profit of almost 150%.

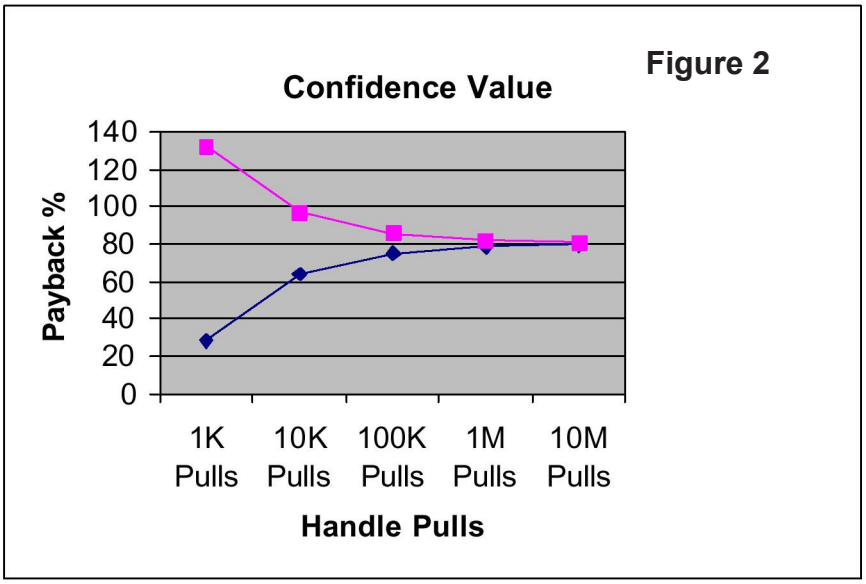
Vir·tu·al (vûr'choo-el) adj. Existing or resulting in essence or effect though not in actual fact, form, or name.

What's really going on here is something called Virtual Stops. Refer to the illustration. With our imaginary reel strip of only eight symbols we can correlate a range of 'virtual' numbers with the physical ones that the player sees.

Now, with a range of seventy-two stops we can create over 30 times the combinations we originally had with only the physical stops. We now have 72 X 72 X 72=373,248 virtual combinations. This number ultimately represents what's known as Machine Cycle.

Don't misunderstand. This is not to say that if I played 373,247 games and I have not yet hit the jackpot, that I will hit it on the very next pull. Think of it as a coin with 373,248 sides. These are your odds on every handle pull.

This begs the question: Is there a limitation on virtual stops? Theoretically, no. 64, 72, 90 and even 200 stop machines are common. Some mega-



progressives can reach well beyond that. The probabilities can really bake your noodle!

Now on to a typical PAR sheet. These are legal documents issued by the manufacturer as proof of the game's theoretical performance. Now the legal mumbo-jumbo starts. But it is in understanding PARs (or PC sheets as they're sometimes called) that you can keep your superiors from crunching antacids whenever customer disputes arise.

Using the sample PAR sheet, we can identify each major section and how it fits in the real world. Section 1 indicates the Average Payback Percentage. This is how much money is returned to the player. This works in tandem with the Hold Percentage, or the amount of money that will be kept by the casino. The sum of these should always equal 100%.

That does not mean that if I deposit $10, I am going to receive $8.04 back. Just below is our "confidence value". This represents that all of the projections on this document are based on 10,000,000 handle pulls. With that many pulls we

SS:#### 3R3CM MU PRC:80.366 HTFQ:11.763 P:H 15:17:47 2-SEP-97 Page: 1

Section 1 **Section 2**

TYPE 5

Section 1

Reel Strip Number #### HOLD % 19.634 Denomination:
MODEL # : XX33X PAYTABLE 245B105
90% Confidence value, 10,000,000 pulls- LOW %: 79.84 HIGH %: 80.89

COIN #	PERCENT PAY BACK	HIT FREQ	TOTAL HITS	TOTAL PAYS
1	80.009%	11.763%	43904.	298632.
2	80.009%	11.763%	43904.	597264.
3	80.366%	11.763%	43904.	899896.

"NUDGE UP" SYMBOLS:01,02,03.
"NUDGE DOWN" SYMBOLS:U1,U2,U3.

SYM	NUMBER / REEL R1	R2	R3
~~	37	41	45
O1	9	0	7
U1	8	1	0
1B	8	3	10
O2	0	10	0
U2	0	0	2
2B	3	9	2
O3	1	0	0
U3	0	1	0
3B	2	2	2
R7	2	3	3
TD	2	2	1

Section 3

This is a 3 reel , 3 Coin 72 stop machine. Reel Combos : 373248.

Section 4

PAY COMBO	# PER REEL	HITS	PULLS/HIT	PAYS	TOTAL PAY
TD XX XX	2 70 71	8726.	43.	2.	17452.
XX TD XX	70 2 71	8502.	44.	2.	17004.
XX XX TD	70 70 1	4088.	91.	2.	8176.
AB AB AB	31 26 23	16592.	22.	5.	82960.
TD TD --	2 2 72	180.	2074.	10.	1800.
-- TD TD	72 2 1	74.	5044.	10.	740.
TD -- TD	2 72 1	82.	4552.	10.	820.
1N 1N 1N	25 4 17	1700.	220.	10.	17000.
AB AB TD	31 26 1	640.	583.	15.	9600.
TD AB AB	2 26 23	896.	417.	15.	13440.
AB TD AB	31 2 23	540.	691.	15.	8100.
2N 2N 2N	3 19 4	228.	1637.	20.	4560.
1N 1N TD	25 4 1	100.	3732.	30.	3000.
TD 1N 1N	2 4 17	136.	2744.	30.	4080.
1N TD 1N	25 2 17	850.	439.	30.	25500.
3N 3N 3N	3 3 2	18.	20736.	40.	720.
2N 2N TD	3 19 1	57.	6548.	60.	3420.

become 90% confident that numbers are correct. It could never be 100% since the machines are based on random events.

Section two shows us the Hit Frequency. This is the average frequency at which a winning condition will occur. It is calculated by dividing the number of hits by the number of possible outcomes.

Machine Cycle / Total Hits = Hit Frequency

Section 3 is called the Distinct Symbols Chart. It shows the total virtual stops associated with the symbols on each individual reel strip. For example; Reel Strip #2 has 41 virtual blanks, even though only eleven appear physically.

Section 4 is the Complete Paytable. Slot machine glass usually only represents an abbreviation, but this is the whole enchilada. Every possible paying condition is shown along with virtual stops, hits and pays.

Section 5 is the Physical Reel Strip Listing. It is here where attention to detail counts! Notice that not all the reel strips are exactly alike. Verify reel strip installation using this chart. Never rely on numbers printed on the bottom of the reel strip. Everybody makes mistakes, including the manufacturer.

Section 6 is the Virtual Reel Strip listing (a.k.a. Expanded Reel Strip Listing). By now, the lights should be coming on. Using the Physical and Virtual Reel Strip listing, we can effectively create a wheel like figure 1.

Take a moment to study both charts. Some very interesting things should start to appear. First, you can see the range of virtual numbers that correspond to the physical. Second, you can note the preponderance of blanks. Casino owners certainly prefer blanks to winning symbols. Lastly, find the top award symbols. In this case it is "TD" . There is a large amount of blanks on either side of this symbol. What's going on here?

This is what I like to call the "Aww Shucks!" Principle. When players see the top award symbol appear just above or just below the payline, it builds anticipation and encourages more play. "Aww Shucks! Just missed it. One more spin and I'll get it."

Section 7 is known as Ninety Percent Confidence Value Chart. And, with this chart we can deduce the probable perfor-

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SS:####  3R3CM  MU  PRC:80.366  HTFQ:11.763   P:H  15:17:47   2-SEP-97 Page:  3
                          Section 5
                      PHYSICAL REEL STRIP LISTING    REEL STRIP # :####
 ------------------------------------------------------------------------------
Line #    1 O1 U3 ~~
Line #    2 1B 1B 3B
Line #    3 ~~ ~~ ~~
Line #    4 R7 R7 R7
Line #    5 ~~ ~~ ~~
Line #    6 1B 1B 2B
Line #    7 U1 U1 U2
Line #    8 2B 2B 1B
Line #    9 ~~ ~~ ~~
Line #   10 TD TD TD
Line #   11 ~~ ~~ ~~
Line #   12 1B 1B 3B
Line #   13 O3 O2 O1
Line #   14 3B 2B 1B
Line #   15 ~~ ~~ ~~
Line #   16 2B 3B 2B
Line #   17 ~~ ~~ ~~
Line #   18 TD TD 1B
Line #   19 ~~ ~~ ~~
Line #   20 1B 2B R7
Line #   21 ~~ ~~ ~~
Line #   22 3B 3B 1B

              3  3  3
              9  9  9
              3  3  3
              2  3  4
```

Cobweb Corner - Advice about Old Machines

Subject: **Bally error code**
From: **Michael Wiley <wec1@altavista.com>**

Hi Randy. I'm having trouble identifying the error code the Bally E series slot I'm working on is giving me. It's a AS2970-20 MPU with an ESMA62683-1720 EEPROM. The game is 3 line, 3 coin JPO. The unit coins up, releases the handle, spins & indexes all 3 reels. Upon index of the third reel, it gives me an 87 error code alternating with # of coins played. All reel readers test OK & the hopper is good.

Got any clue what's up? If not, any idea who I could talk to who's good with Bally E series stuff? Any help is appreciated.

Yours, Mike Wiley

Subject: **Bally slot fixed**

Randy,
Thanks for responding to my slot machine question. I found a faulty MC14020 that was making my MPU think it was in a diagnostic test in spite of the DIP settings. God I love fixing stuff!

Yours, Mike Wiley

mance of a given machine.

In theory, if you were to flip a fifty-cent piece ten times, it could land on heads every time. Further, in theory, if you were to flip the same coin 100 times it could land tails every single time. But if we follow the law of averages over time, say 1000 flips, our ratio would fall to 50/50. In other words the longer we do something over and over again, the more accurately we can predict the outcome of the next event. But ultimately we can never predict with 100% certainty.

In fact, to be reasonable, we can kick out 10% reliability because some really wacky stuff can happen based such a small sampling. What's left is a 90% confidence value in our predictions.

Refer to the graph in figure 2. This supports the previous statements. The upper and lower end possibilities converge to the center over time. Furthermore, the average of the upper and lower percentages always equal Average Payback Percentage and conversely the Hold Percentage.

Does your brain ache yet? Hold on, I haven't told you about Volatility Index yet.

At this point the arithmetic can get very complex. We'll keep it simple, but explaining this to your slot director just might get

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SS:####  3R3CM  MU  PRC:80.366  HTFQ:11.763   P:H  15:17:47   2-SEP-97 Page:
                                  Section 6
                          EXPANDED REEL STRIP LISTING  REEL STRIP # :####
 ------------------------------------------------------------------------------
Line #   1 O1 U3 ~~       Line #  40 TD O2 O1
Line #   2 O1 1B ~~       Line #  41 ~~ O2 O1
Line #   3 O1 ~~ ~~       Line #  42 ~~ O2 O1
Line #   4 O1 ~~ 3B       Line #  43 ~~ O2 1B
Line #   5 O1 ~~ ~~       Line #  44 ~~ O2 1B
Line #   6 O1 ~~ ~~       Line #  45 1B 2B ~~
Line #   7 O1 ~~ ~~       Line #  46 1B ~~ ~~
Line #   8 O1 R7 ~~       Line #  47 O3 ~~ 2B
Line #   9 O1 R7 ~~       Line #  48 3B ~~ ~~
Line #  10 1B R7 ~~       Line #  49 ~~ ~~ ~~
Line #  11 1B ~~ R7       Line #  50 ~~ 3B 1B
Line #  12 ~~ ~~ ~~       Line #  51 ~~ ~~ ~~
Line #  13 ~~ ~~ ~~       Line #  52 ~~ ~~ ~~
Line #  14 ~~ ~~ ~~       Line #  53 ~~ ~~ ~~
Line #  15 ~~ ~~ ~~       Line #  54 2B ~~ ~~
Line #  16 ~~ ~~ ~~       Line #  55 2B ~~ ~~
Line #  17 R7 1B ~~       Line #  56 ~~ TD ~~
Line #  18 R7 U1 2B       Line #  57 ~~ ~~ ~~
Line #  19 ~~ 2B U2       Line #  58 ~~ ~~ ~~
Line #  20 ~~ 2B U2       Line #  59 ~~ ~~ R7
Line #  21 ~~ 2B 1B       Line #  60 ~~ ~~ R7
Line #  22 ~~ 2B 1B       Line #  61 ~~ ~~ ~~
Line #  23 1B ~~ 1B       Line #  62 TD 2B ~~
Line #  24 1B ~~ ~~       Line #  63 ~~ 2B ~~
Line #  25 U1 ~~ ~~       Line #  64 ~~ 2B ~~
Line #  26 U1 ~~ ~~       Line #  65 ~~ 2B ~~
Line #  27 U1 ~~ ~~       Line #  66 ~~ ~~ ~~
Line #  28 U1 TD ~~       Line #  67 1B ~~ ~~
Line #  29 U1 ~~ TD       Line #  68 1B ~~ ~~
Line #  30 U1 ~~ ~~       Line #  69 ~~ ~~ 1B
Line #  31 U1 ~~ ~~       Line #  70 ~~ ~~ 1B
Line #  32 U1 ~~ ~~       Line #  71 ~~ ~~ 1B
Line #  33 2B ~~ ~~       Line #  72 3B 3B 1B
Line #  34 ~~ 1B ~~
Line #  35 ~~ O2 3B                  3  3  3
Line #  36 ~~ O2 O1                  9  9  9
Line #  37 ~~ O2 O1                  3  3  3
Line #  38 ~~ O2 O1                  2  3  4
Line #  39 ~~ O2 O1
```

you that pay raise and buy your kids that G.I. Joe with the Kung Fu grip. Suffice it to say this number represents how fast the upper and lower percentages converge to the center of the chart or how quickly the numbers get reliable.

Another way to view this number is to think of it as a "risk" to the casino. The higher the number, the higher the risk. For example, A game with a top award of 2500 credits will have a lower V.I. than a game with 50,000 as it top award. Both games are susceptible to hit the jackpot in the very first handle pull but the latter will cost the casino more. Additionally, the lower paying game will not entice nearly as many players as the higher paying machine. Having a grasp on these concepts can help Slot Operations decide which games are right for the property. So, it's a calculated risk. What can the casino afford?

Various other data are contained on the PAR sheet. Unique symbols, paytable firmware identification and game type just to name a few.

To be fair, the sample PAR used was one of the easiest I could find to read. The more paylines, reels and bonus games, the more sophisticated the PAR sheet becomes. But this is a good foundation to understanding even latest and more complex documents out there.

Feeling a new appreciation for the word "malfunction"?

How much can a misaligned reel strip cost us? A few dollars, big bucks, our jobs?

Part two of this article will address stepper motor theory and effective Reel Strip and Paytable tests and one more thing that only best slot techs know. But you'll just have to read about it in next month's issue, won't you? Hopefully, by then you will be up to PAR.

Ken Locke is a Technical Trainer with the Gaming Systems Department of International Game Technology in Reno, NV. He has traveled to gaming jurisdictions throughout the world to train casino personnel on nearly all aspects of slot operations. Currently, he works on the new EZ Pay Ticket-In Ticket-Out installation team. Contact him at Ken.Locke@igt.com

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SS:####   3R3CM   MU   PRC:80.366   HTFQ:11.763    P:H   15:17:47    2-SEP-97 Page:


                          Section 7
                  90% CONFIDENCE VALUES      VOLATILITY INDEX =    16.483
    HANDLE PULLS      LOWER          UPPER
                    PERCENTAGE    PERCENTAGE
          1000.       28.24          132.49
         10000.       63.88           96.85
        100000.       75.15           85.58
       1000000.       78.72           82.01
      10000000.       79.84           80.89
 PAY TABLE  FILE NAME   : PTDAT:SS####.PAY
 REEL STRIP FILE NAME   : RSDAT:SS####.LAY
 OPERATOR'S INITIALS: DL
                                  COMMENTS
_____________________________________________________________

 PAY TYPE.........:   Pays Only Highest Winner Per Lit Line
                   :_____________________________________________
 FROM SS #........:
                   :_____________________________________________
 TO SS #..........:
                   :_____________________________________________

 Special Symbols
AB  : O1,U1,1B,O2,U2,2B,O3,U3,3B
1N  : O1,U1,1B
2N  : O2,U2,2B
3N  : O3,U3,3B
```

Dion's Corner

By Dion Anderson

Coin-In Ghost

I found an interesting problem tonight with the new I-Game upright. It had a coin-in jam tilt. I changed out the coin-in optics and swapped out the two I/O boards next to the CPU but the tilt would not clear. I thought that maybe the CPU itself was the problem so I changed it out and cleared RAM next but still nothing. I started to trace the wires, which lead me to another I/O board on the door that I had totally forgotten about. I swapped it for a good one and both machines came up (Typical!). The problem was likely caused by opening and closing the door so much that the I/O board had become unseated.

I suppose that the moral to this story is that when you have a coin-in tilt that won't clear, check your door I/O. Hopefully that will solve your problem and save you some time.

C.D.S

Here's a quick one for your C.D.S Tracking system. Often, you get a cal or a variance or override. The list goes on. Anyway, you get to the game and check all of your global settings and they check good. You decide to take a look at the sentinel board to see if you have TX and RX. While you're there, you notice that you have everything including POWER but you have a very weak WATCHDOG. To save a lot of time, try changing U1 on the sentinel board. I have found that this restores your watchdog back to a full signal even if you had none to start with. U1 is the square IC next to the EPROM.

The 200 and W.B.A

I'm sure all of you that have DBV 200 bill validators know that they just go to sleep. I'm not sure why, but they do it. I have noticed that if you calibrate them (DIPS 1-4 on, off for the rest) this usually will keep them up for a lot longer. Remember that after you calibrate it, make sure your BV light is flashing before you unplug and flip your dips back to normal accept mode. If you don't, the head will not write the new calibration parameters to E-SQUARE and you will have what you started with.

If you get one that will not accept even after you calibrate it, try flipping dipswitch eight on. You should get a cycle. Unplug and put the dips back to normal accept mode. That should bring it out of never-never land or wherever it is that it goes. Try the calibration again and try the bill. You should be back in business.

Quick Tip for Odyssey

Here's a good tip for those annoying Odyssey games that can do some pretty strange things at times. Although most of the time they are pretty reliable, they have their moments. Usually, they aren't too confusing but when you have one that won't load (it just stays in the loading screen) the first thought that comes to mind is a soft clear (dip switch #4). A soft clear usually solves the problem but in this case, it still won't load. Okay, then let's do a full clear (dip #6). That will do the trick for sure. &#@&!, it still won't load. Well, to save you a long process, take out the psycho board. I swear, It's labeled psycho board and probably for a good reason! Anyway, replace U1 if you have one. If not, get the E.T. (electronics technician) to burn a few. Now it will load properly. If you did the full clear while troubleshooting, enjoy the setup process and don't forget to HAVE FUN OUT THERE.

Dion Anderson
danderson@slot-techs.com

Dion Anderson is the lead technician at Circus Circus in Reno, Nevada.

Incandescent Lamps and Player Panels

By Herschel Peeler

Incandescent lamp can be run at voltages other than the rated voltage. Running the lamp at a little less than the rated voltage will prolong the life of the lamp at a small sacrifice to brightness. Likewise, running the lamp at higher than its rated will shorten the life of the lamp, but give a brighter operation.

Lamps run at a rated voltage. At that voltage it will draw a certain current, give off a certain brightness, and have an expected life of so many hours.

Referring to the chart below:

Voltage is the rated voltage, by design.
Amps is the current it should draw at that voltage.
MSCP is the Mean Spherical Candle Power. How much light the lamp will emit.
Life is the expected life of the lamp, in hours.

As we can see by the chart below, running a lamp at 90% of its rated voltage extends the life of the bulb by about 350%, and decreases brightness to 70% of normal. A decrease of just 1% increases the lamp life by about 12%. Likewise running a bulb at 1% above its rated value decreases its life by 12%. Running the lamp at 110% of its rated voltage shortens its life to 30%.

To apply this to the real world, one manufacturer, we shall call Mr. B., uses 6.3 Volt lamps (#86, #159, #55), and runs them off of 7.5 Volts. This is a 20% increase in voltage. The life of the bulb is shortened to 11% of its normal life.

Of course, the above chart is a general statement. Individual lamps will vary. The chart is quoted from a manufacturer of incandescent lamps. This represents an average life expectancy, quoted by the manufacturer.

Volts	Amps	MSCP	Life
70%	82.2%	28.7%	7225%
75%	85.4%	36.5%	3157%
80%	88.5%	45.8%	1455%
85%	91.4%	56.6%	703%
90%	94.4%	69.2%	354%
95%	97.2%	83.6%	185%
97%	98.3%	90%	144%
99%	99.4%	96.5%	113%
100%	100%	100%	100%
101%	100.5%	103.5%	88.7%
103%	101.6%	111%	70%
105%	102.7%	119%	56%
110%	105.4%	140%	32%
115%	108%	163%	18.7%
120%	110%	189%	11.2%
125%	113%	218%	6.9%
130	115%	250%	4.3%

With 4,000 games on the floor, for instance, and 8 bulbs per game, we have 32,000 bulbs in the games on the floor. With a life expectancy of 2,000 hours for the bulbs, we have a lot of bulbs failing per day, per week, per month, and per year.

The cost of the bulb, itself, is minimal when purchased in high quantity (maybe $0.35 a piece). The cost of replacing the bulbs is a more significant concern. Thousands of man-hours per year can be wrapped up in just replacing light bulbs.

The solution is to replace the incandescent lamps with LEDs. The development of white LEDs has grown to include drop-in replacements for the more popular incandescent bulbs. If you were a student in our class, you have seen first hand how much abuse LEDs can be exposed to. They can be pushed far beyond the rated suggested current before they fail. Rated life expectance of an LED is 100,000 hours. I suspect it of being higher, but it is hard to rate anything higher than that. The LED has not been around for much longer than that.

There are other small advantages of LEDs over incandescent bulbs. Incandescent bulbs are not white; they are yellow. Next to the bluish white of white LEDs, there is no comparison for appearance. LEDs use much less power. The LED draws only 20 mA, compared to the incan-

descent lamps, which draw 80 mA to 150 mA, or more. A small savings in power, but a large savings in heat. Many of the failures in player panel switches are due to the heat deforming the switch housing, causing the button to stick. LEDs can give off suitable light with almost no heat.

Manufacturers of gaming machines are moving to include LEDs in their player panels. IGT has had a red LED as an option for a number of years. White LEDs are coming of age. The white LED that replaces incandescent indicator lamps had to have always been an objective of LED manufacturers. It has arrived.

Tower lamps will follow. Currently LEDs are hard pressed to send out light to the sides of the bulb. Incandescent bulb brightness is rated in MSCP (Mean Spherical Candle Power). The light is emitted in all directions (spherically). In LEDs, the light is emitted in one primary direction, within only a 30 degree, or so, cone. Multiple LED units are available to accomplish emitting in some pattern close to spherical, but these prices are still high. Time will bring them down. The other alternative might be to change the design of the tower to accept multiple outward pointing lamps.

Other uses for white LEDs include, but certainly is not limited to, a replacement for fluorescent lamps. The design of fluorescent lamps, as used in gaming machines, is terribly inefficient. Most of the voltage is lost across the ballast. The ballast and lamp create abundant heat in the game. The radiation from the bulb turns plastic components brittle. The electrical noise generated can play havoc with the game microprocessor.

A panel of white LEDs, giving off similar brightness, would run on 10 Watts of power, almost all directed to light. Cost of such an assembly would be high, initially, but it would have a life expectancy equal to the life of the machine. LEDs do not flicker, as fluorescent lamps do, when they start to go out.

Fluorescent lamps account for another major labor expense and add considerably to the repair parts inventory. Typical life expectancy of fluorescent lamps is also in the 1,000-hour range.

Both of these can be quick add-on improvements to games already in the field. The white LEDs for the player panels are an immediate drop-in upgrade.

Today we get rid of those yucky-yellow lamps. New games will replace the incandescent and fluorescent lamps with white LEDs. Next we work on those mechanical player panel switches.

The Zener Diode

zener diode - NOUN:
A silicon semiconductor device used as a voltage regulator because of its ability to maintain an almost constant voltage with a wide range of currents.

Over the past few months, we've looked at many different types of semiconductors here in the pages of Slot Tech Magazine. We've looked at conventional diodes and bi-polar transistors. We've looked at MOSFETs. We've looked at SCRs and TRIACs. It's been a fun ride but we're not through yet. There is another type of diode that we use in games and in electronics in general. It's called the Zener diode.

Everyone's very curious about Zener diodes because they have such a strange name, "Zener." Where did the name come from? What does it mean? As is common in the world of electronics, it's named after a dead guy but not too long dead, this time. In fact, he was very much alive and well (and working in the physics community) when the Zener diode was developed. It was named for the U.S. physicist Clarence Melvin Zener (1905-1993), whose research led to the creation of the device.

Reports have falsely attributed the naming of the diode to "Frank Zener" and to "Karl Zener." Research on the subject reveals that Mary Holmes Dague sent the following letter (response sent from mail@cartalk.com):

The gentleman was CLARENCE Zener and he did NOT invent the diode! I know: I was his personal secretary when he was working on solar sea power in the 1970s.

OK, guys, get this straight: CLARENCE Zener was a HARVARD man, with degrees in mathematics and physics. In the late 1920s, he wrote a paper speculating properties of electricity. Bell Labs then invented the diode and named it for Zener. CLARENCE Zener was the first to admit he was all thumbs in the lab; he reveled in inventing new ideas. Zener was strictly a theorist.

- end of letter -

Zener was a professor of physics at Carnegie Mellon University in Pittsburgh. He was 87 years old when he died July 2, 1993. Zener had received his Ph.D. in physics from Harvard University in 1929. Throughout his career, he taught at many schools, including Washington University in St. Louis (1935-37) and the City College of New York (1937-40). He was dean at Texas A&M University before joining Carnegie Mellon in 1968. He held the highest class of membership in Sigma Pi Sigma fraternity, given only to distinguished physicists and related scientists who have made valuable contributions to physics at the national level.

Zener won the Von Hippel Award, the Materials Research Society's highest honor, which recognizes those qualities most prized by materials scientists and engineers—brilliance and originality of intellect, combined with vision that transcends the boundaries of conventional scientific disciplines.

Dr. Zener performed the definitive work on internal friction in solids. His influence is most visibly expressed in the line of research that resulted in the invention of the Zener diode and laid the foundation for the development of semiconductors.

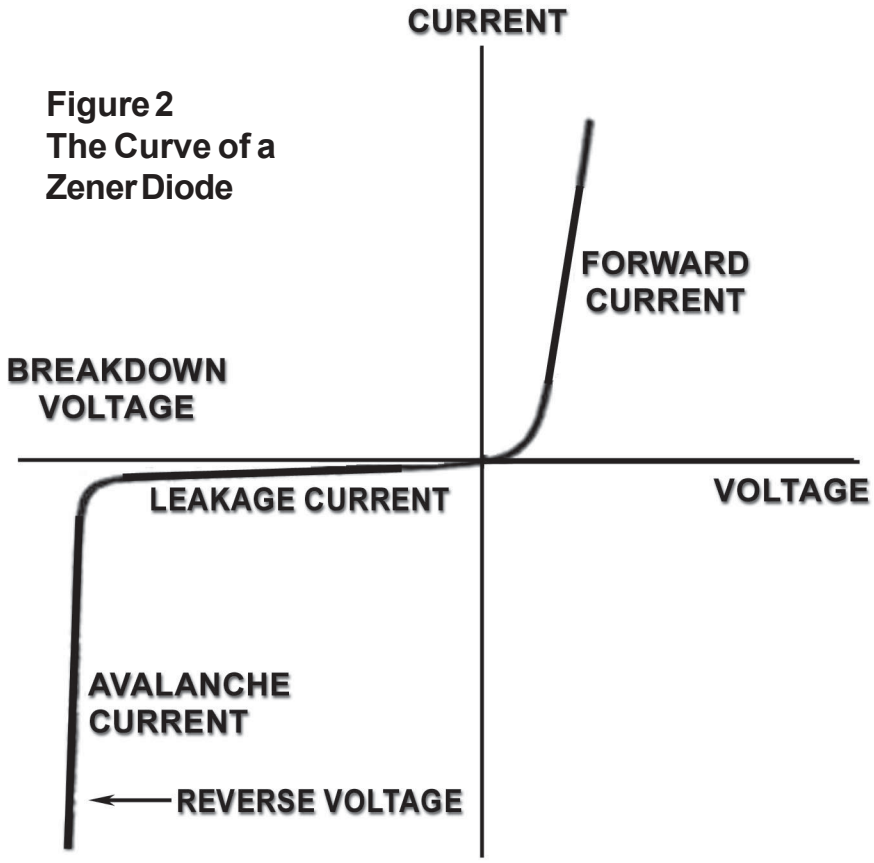


Figure 2
The Curve of a Zener Diode

GENERAL SEMICONDUCTOR®

1N4728 thru 1N4764

Zener Diodes

Electrical Characteristics (T_A = 25°C unless otherwise noted). Maximum V_F = 1.2V at I_F = 200mA

Type	Nominal Zener voltage[3] at I_{ZT} V_Z (V)	Test current I_{ZT} (mA)	Maximum Zener impedance[1] Z_{ZT} at I_{ZT} (Ω)	Z_{ZK} (Ω)	at I_{ZK} (mA)	Maximum reverse leakage current I_R (μA)	at V_R (V)	Surge current at T_A = 25°C I_R (mA)	Maximum regulator current[2] at T_A = 50°C I_{ZM} (mA)
1N4728	3.3	76	10	400	1.0	100	1	1380	276
1N4729	3.6	69	10	400	1.0	100	1	1260	252
1N4730	3.9	64	9	400	1.0	50	1	1190	234
1N4731	4.3	58	9	400	1.0	10	1	1070	217
1N4732	4.7	53	8	500	1.0	10	1	970	193
1N4733	5.1	49	7	550	1.0	10	1	890	178
1N4734	5.6	45	5	600	1.0	10	2	810	162
1N4735	6.2	41	2	700	1.0	10	3	730	146
1N4736	6.8	37	3.5	700	1.0	10	4	660	133
1N4737	7.5	34	4.0	700	0.5	10	5	605	121
1N4738	8.2	31	4.5	700	0.5	10	6	550	110
1N4739	9.1	28	5.0	700	0.5	10	7	500	100
1N4740	10	25	7	700	0.25	10	7.6	454	91
1N4741	11	23	8	700	0.25	5	8.4	414	83
1N4742	12	21	9	700	0.25	5	9.1	380	76
1N4743	13	19	10	700	0.25	5	9.9	344	69
1N4744	15	17	14	700	0.25	5	11.4	304	61
1N4745	16	15.5	16	700	0.25	5	12.2	285	57
1N4746	18	14	20	750	0.25	5	13.7	250	50
1N4747	20	12.5	22	750	0.25	5	15.2	225	45
1N4748	22	11.5	23	750	0.25	5	16.7	205	41
1N4749	24	10.5	25	750	0.25	5	18.2	190	38
1N4750	27	9.5	35	750	0.25	5	20.6	170	34
1N4751	30	8.5	40	1000	0.25	5	22.8	150	30
1N4752	33	7.5	45	1000	0.25	5	25.1	135	27
1N4753	36	7.0	50	1000	0.25	5	27.4	125	25
1N4754	39	6.5	60	1000	0.25	5	29.7	115	23
1N4755	43	6.0	70	1500	0.25	5	32.7	110	22
1N4756	47	5.5	80	1500	0.25	5	35.8	95	19
1N4757	51	5.0	95	1500	0.25	5	38.8	90	18
1N4758	56	4.5	110	2000	0.25	5	42.6	80	16
1N4759	62	4.0	125	2000	0.25	5	47.1	70	14
1N4760	68	3.7	150	2000	0.25	5	51.7	65	13
1N4761	75	3.3	175	2000	0.25	5	56.0	60	12
1N4762	82	3.0	200	3000	0.25	5	62.2	55	11
1N4763	91	2.8	250	3000	0.25	5	69.2	50	10
1N4764	100	2.5	350	3000	0.25	5	76.0	45	9

Notes:

(1) The Zener impedance is derived from the 1KHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units

(2) Valid provided that electrodes at a distance of 10mm from case are kept at ambient temperature

(3) Measured under thermal equilibrium and DC test conditions

Unconventional Diode

Now that we know all about the origin of the name, what does a Zener diode do and how is it used? A Zener diode doesn't really behave much like an ordinary diode. In fact, although it's called a "diode" (because it has two leads) that's really where the similarity ends.

You can kind of get a clue about this right away when you look at the specification chart in figure 1. Look at the voltage ratings. Typical rectifier diodes like the popular 1N4000 series are found with voltage ratings such as 50 volts, 100 volts, 200 volts, 400 volts, 600 volts or 1000 volts. These Zener voltages are generally much lower and very specific. Here we're looking at voltages like 3.3V, 5.6V, 6.8 V and so on. Obviously, this means something completely different.

Also unlike a normal rectifier diode (and virtually every other semiconductor) the schematic symbol of the Zener diode doesn't always point in the direction of conventional current flow. Yes, current will flow through the Zener diode if it is forward-biased but it is rarely operated that way, as it is not particularly useful. It is when the Zener diode is reverse-biased that its unique properties come into play.

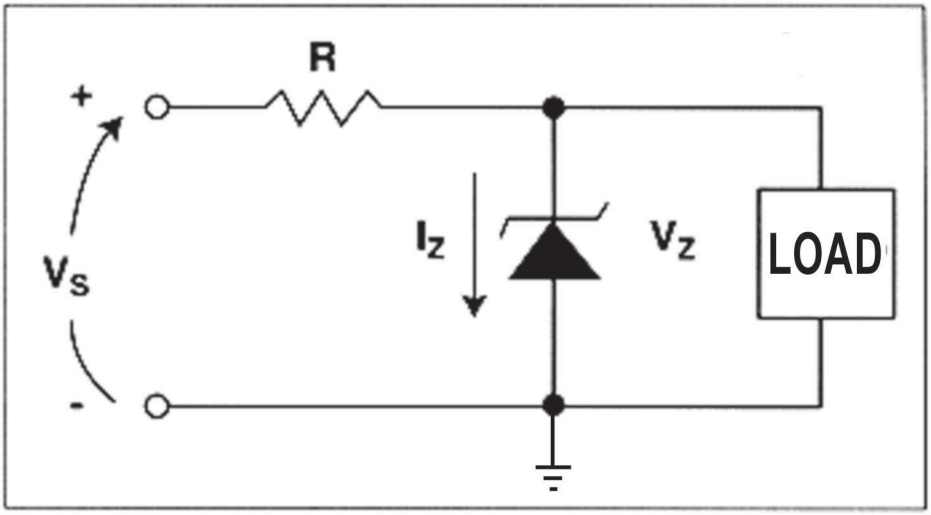
When reverse-biased, a normal diode will block the current flow up to the point where it reaches its breakdown voltage. This is known as the diode's "peak reverse voltage" or PRV. If the PRV is exceeded, a conventional diode suffers catastrophic breakdown and failure, typically short-circuiting.

But a Zener diode is designed to breakdown. However, it's not a catastrophic breakdown. Referring to the curve in the figure 2, notice that as the reverse voltage is increased, the leakage current remains essentially zero until the breakdown voltage is reached. At this point, the current increases dramatically. This breakdown voltage is the Zener voltage. For the conventional rectifier or diode, this is the point at which it fails. However, the Zener diode is intended to operate at that specific voltage, so we often us it as a voltage regulator.

In a nutshell, here's how it works: Like a conventional diode, the Zener diode would allow current to flow through it when it is forward biased but as mention previously, it doesn't really do anything useful in that operating mode. Also like a conventional diode, the Zener diode will block the reversed current as long as the voltage at the cathode is less than the specified Zener voltage. However, if the Zener voltage is exceeded, the Zener diode will begin to conduct opposite the direction that the arrow symbol is pointing.

To further clarify things, let's use a 12 volt Zener diode as an example. A quick look at the chart in figure 1 and we see that a 1N4742 is a 12 volt unit so let's call it that. If the voltage at the cathode is less than 12 volts, the diode will not conduct. However, if the cathode voltage exceeds the Zener voltage (let's say 13 volts) the Zener diode begins to conduct. But it doesn't just snap on like a switch. The Zener diode wants to keep a constant voltage across itself. In this case, it's 12 volts. The Zener diode conducts just enough to keep the first 12 volts for itself and then puts out 1 volt at the anode. If we were to put 20 volts at the cathode of the 1N4742, it would keep the first 12 volts and put 8 volts out the anode. If we were to put 100 volts at the cathode of the 1N4742, it would keep the first 12 volts and put 88 volts out the anode.

So, a Zener diode can provide us with a known voltage drop. It can be used to cut down a voltage by a certain, specific number of volts. However, that is not the most common way to see a Zener diode being used. The Zener diode is most commonly connected in the circuit shown in figure 3; its anode grounded and cathode connected to a power supply. In a circuit like this, the voltage at the load is pegged at the Zener voltage and cannot go any higher. Even if Vs (the unregulated supply voltage) goes higher than the Zener voltage, any excess voltage is dropped



Vs must be greater than Vz to permit regulation

Figure 3 - The Zener as a voltage regulator

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across the resistor. The resistor is one half of a voltage divider circuit. The other half of the voltage divider is formed by the impedance of the load in parallel with the impedance of the Zener diode which is continuously adjusting itself in order to maintain its exact Zener voltage between the cathode and the grounded anode. Think of it as a self-adjusting voltage divider.

Another use for a Zener diode is as an over-voltage detector such as the x-ray protection circuit in a monitor (see figure 4). In this circuit, the Zener diode is used to monitor the voltage at a winding on the flyback transformer. This flyback-derived AC voltage is rectified by a conventional (albeit high-speed) diode and filtered by an electrolytic capacitor to form a DC voltage that is directly proportional to the EHT at the second anode of the CRT. In other words, if the EHT at the second anode rises, so will this flyback-derived DC voltage as well.

Typically, this might be something like a 1N4740, 10 volt Zener diode. Under normal circumstances, the voltage at the cathode of the Zener diode will be less than 10 volts. However, should the EHT rise in voltage (due to a power supply regulation failure, for example) the voltage at the cathode of the Zener diode will exceed 10 volts, causing the diode to conduct. The DC voltage that now appears at the anode of the Zener diode (remember, it conducts the opposite of the way the arrow points) is passed to the shutdown input of the horizontal oscillator IC, promptly killing the oscillator and, of course, the rest of the horizontal/high voltage circuits as well.

Zener Diode Failures

When Zener diodes fail, they often short circuit as conventional diodes do. However, a Zener diode will often shift its Zener voltage (usually going lower) when it fails without shorting completely. This makes it impossible to perform a static, power-off test on a Zener diode with this type of failure. You must measure the voltage across the Zener diode in order to test it properly when it is being used in a voltage regulator circuit such as shown in figure 3.

Zener Diode Specifications

Referring again to figure 1, although you'll find a myriad of specifications listed, there are just three main specifications for Zener diodes:

1.) The Zener voltage. The most common range of Zener voltage is 3.3 volts to 100 volts.

2.) The tolerance. The most common tolerance ratings are 5% and 10%

3.) The dissipation. This is measured in watts. It refers to the Zener diode's ability to dissipate heat. Common sizes in our industry are 250 mw, 500 mw and 1 watt. 2 watt Zener diodes are used occasionally as well.

Substitution is not the same for Zener diodes as it is for conventional rectifier diodes. With a rectifier diode, you can always use a diode of a higher voltage rating as a substitution. A 400 volt diode can be used to replace a 50 volt diode, for example. Not so with a Zener diode. A bad Zener diode must be replaced with one of the same voltage rating. The tolerance can remain the same or it can be more precise, substituting a 5% device for a 10% device. Dissipation can be increased as much as you'd like.

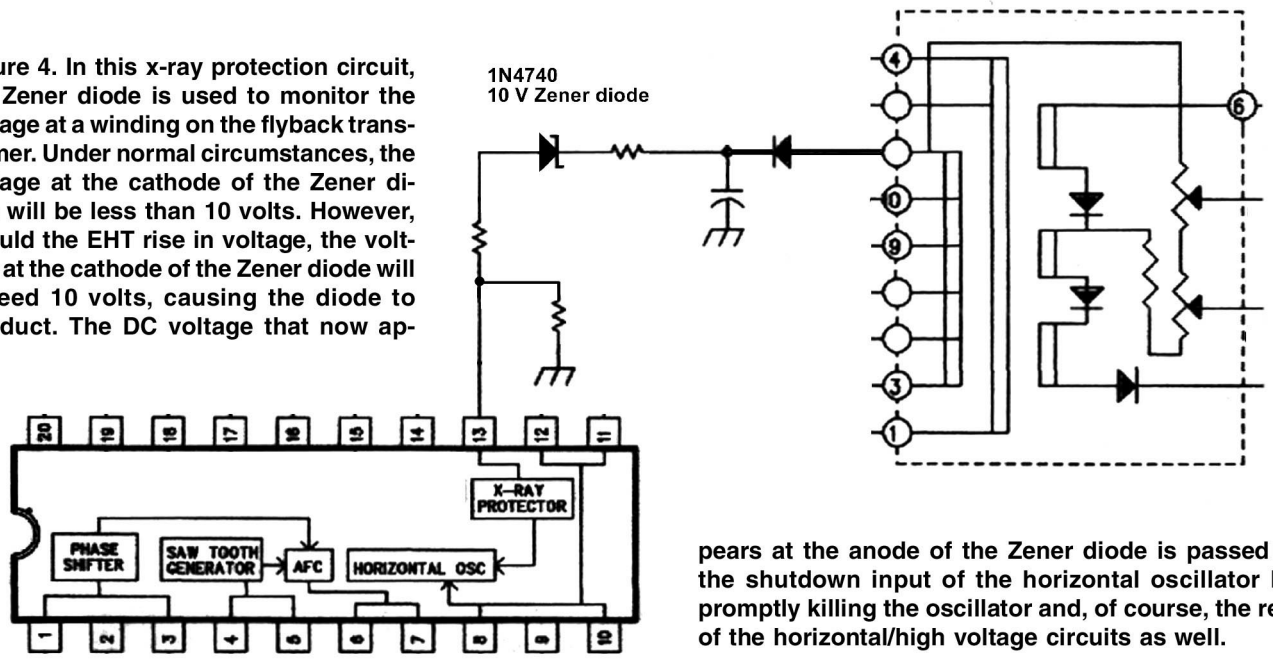


Figure 4. In this x-ray protection circuit, the Zener diode is used to monitor the voltage at a winding on the flyback transformer. Under normal circumstances, the voltage at the cathode of the Zener diode will be less than 10 volts. However, should the EHT rise in voltage, the voltage at the cathode of the Zener diode will exceed 10 volts, causing the diode to conduct. The DC voltage that now appears at the anode of the Zener diode is passed to the shutdown input of the horizontal oscillator IC, promptly killing the oscillator and, of course, the rest of the horizontal/high voltage circuits as well.

KENO LIGHT PENS

By Pete Bachran

IGT has been building keno games for a long time now, from the tall double screen three board games that oddly carried a Bally logo on the processor board, to the Fortune Two version to the humpback Player's Edge. These games have been very successful to the casino and are still enjoyed by many loyal players.

These games all use the IGT light pen to pick the numbers. Part of the reason IGT has been so successful with this game is that they are very reliable. This pen is much simpler in design than that of any competitor and will withstand much more abuse on the casino floor. They will eventually be replaced with touch-screen number selection however until that time, there will be light pens that need repair.

When called to a Keno game where the pen won't mark, the first thing to try is cleaning the tip of the pen. A cotton or foam tipped swab is perfect for this purpose. Press it against the tip and give it a twist to clear the opening and clean the end of the fiber optic. Try marking again. If it works, move on. If not, check the monitor. Is it as bright as the other monitors on that row of games? Try adjusting the brightness. Perhaps a little more light output is all that is needed. Don't adjust the monitor brighter than its neighbors but be sure it's just as bright. These two checks will solve about half of the "not marking" problems with no inconvenience to the player.

The next step is to open the game and unplug the fiber optic from the interface board. Shine a light into one end of the fiber optic cable. Is there a bright light showing at the other end? If not, replace the pen.

If the optic appears okay, unplug the two-wire connector that connects the light pen to the interface board. Be sure that the wires are well seated into the connector and reseat the connector. If the light pen now works, great. If not, replace the light pen.

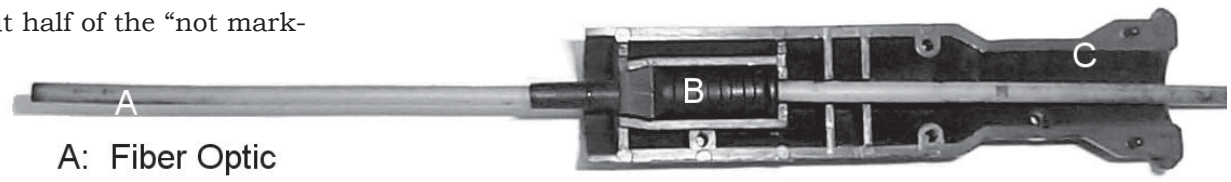
If the light pen has been replaced and the game is up and running properly, you have a bad light pen that needs work. Head for the shop. Not many tools are needed to rebuild a Keno Light Pen.

A digital VOM
A soldering iron
Razor blade

The light pen is held together with pressure fitted parts. They should come apart with relative ease. The main housing should slip off when pressure is applied. If prying is needed, do so carefully so as not to damage the plastic housing parts. Once apart, the housing will contain the Actuator Tip and the Compression Spring.

The main housing should be straight and the Actuator Tip should slide freely in its setting. The Actuator Tip should be straight and the channel that holds the fiber optic should be free from debris. Some visible wear on the tip is normal. The spring should be round and about 7/8ths of an inch long. If not, these parts should be cleaned or replaced. If good, set these parts aside to await re-assembly.

Back to the main portion of the light pen. There is a small roll pin holding the upper and lower inserts together. Without removing the roll pin, gently separate the two halves. As the inserts come apart, the small L-shaped switch actuator will fall onto the bench. The fiber optic will be seated into the lower insert. The switch with the two wires will be seated into the upper insert. Remove the Inserts. Look carefully at each of these inserts. At the flange around the base end, there should be a small arm that will lock into the main housing during re-assembly. If this lock arm is missing, replace the insert.



A: Fiber Optic

B: Modified Optic Connector

C: Lower Insert

Continued on page 20

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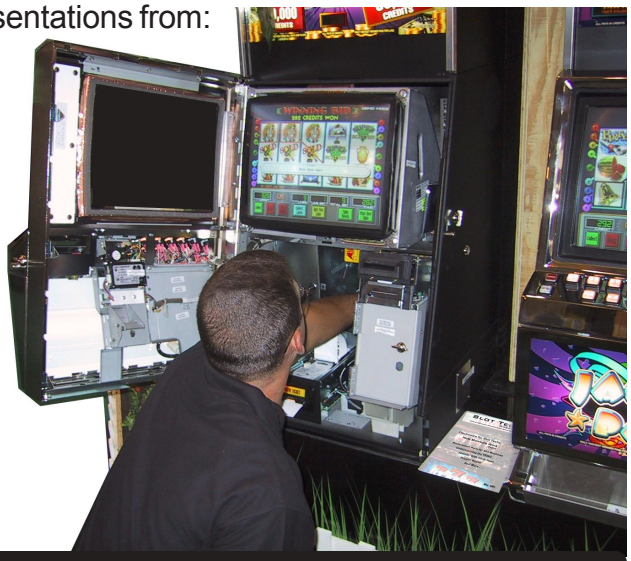

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Luncheon sponsored by:
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1:00pm - 3:00pm
JCM - BV troubleshooting and repair

3:00pm - 3:30pm
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3:30pm - 5:30pm
MicroTouch - Touchscreen Technology

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Asahi Seiko - Hopper troubleshooting and repair

s3:00pm - 3:30pm
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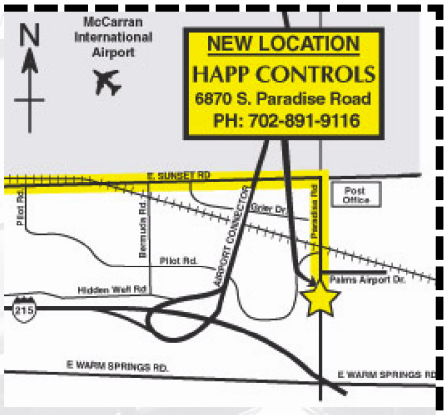

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Also, check in the upper insert where the small snap switch seats. If the slotted holes are elongated so that the switch has movement while in place, replace the upper insert. The switch actuator arm should be straight and just about one 1 1/16th" long. If bent or shorter than 1 1/16" or if the short length is broken or missing, replace it. After inspection, set these parts aside.

Inspect the armored cable. The large "screw" that the cable runs through (where the light pen attaches to the machine body) is held in place with small Allen screws. By being adjustable, the same light pen can be used on either upright or humpback machines. On the insert end, there is a groove pressed into the metal that fits around the roll pin in the upper insert. If the armored cable is broken or if it is unwrapping itself, replace it. This is a good time to clean it; after all, it is supposed to be a silver color.

Running through the armored cable is the fiber optic and two wires. First, check the fiber optic. There should be strong light coming through if a flashlight is held to one end. If the light is dim, cut a small slice off the pen end of the fiber and check again (cutting the fiber optic will be discussed shortly). If the light is bright but it appears that the end of the fiber optic is not pressed all the way into the fiber optic connector, try to press it further in and check again. Cut off the connector and replace it with a new connector if needed. If the light is still dim or nonexistent, there is a break in the fiber optic and it will need to be replaced. Cut the fiber optic line, pull it from the armored cable and discard.

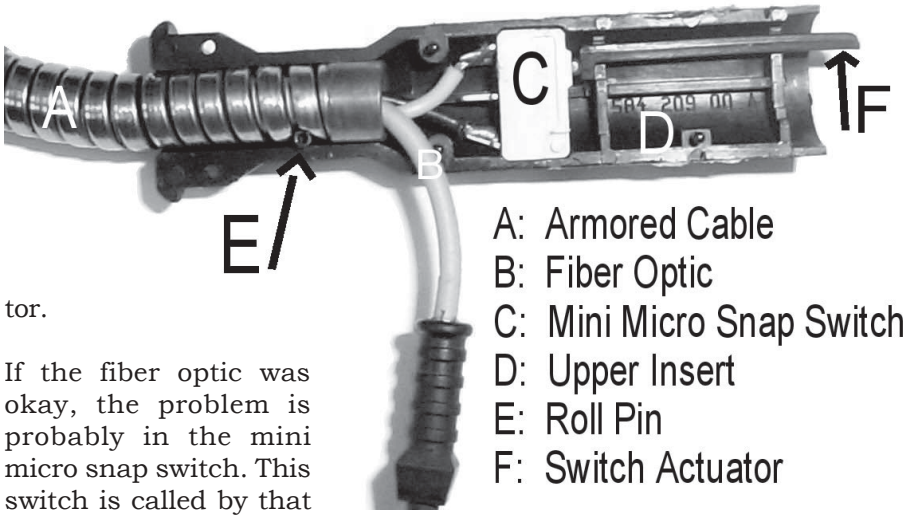
There is much mystery about the proper cutting of fiber optic line. If you are dealing with high speed data transfer, there are special tools, cutters, sanding blocks, holders and plastic abrasive sheets that are needed. It's all very expensive and difficult. However, a Keno Light Pen is LOW tech, slow speed data transfer. All that is needed is a sharp single edge razor blade and a hard flat surface. The bench will do fine.

Lay the fiber optic cable on the flat surface. Place the blade straight up and down on the fiber optic where the cut is to be made. Use a rolling motion to roll the fiber optic away from you while applying pressure to the razor blade. This will produce a clean flat cut that is perfectly suitable for picking Keno numbers.

If you're replacing a bad fiber optic line, cut a new piece forty-eight to fifty inches long. Feed the fresh line into the armored cable until it appears at the other end. On the machine end of the line, insert the fiber optic into an optic connector until it is seated fully then gently crimp. Take another fiber optic connector and carefully cut off the end so that it will slide all the way onto the fiber optic. On the pen end of the line, take this modified connector and slide it about four inches down the fiber optic but don't crimp this connector yet. Take the lower insert, place the connector into it, and place the spring and actuator tip on the fiber optic. Press the actuator to depress the spring and mark the fiber optic at the point it emerges from the tip. If it doesn't then pull more fiber optic through the modified connector. Cut the Fiber optic so that when the actuator tip is in place and depressed the fiber is almost but not quite at the tip, then gently crimp the connector.

If the fiber optic was okay, the problem is probably in the mini micro snap switch. This switch is called by that name for the obvious reason that it is really small. Using a digital VOM or digital multitester, test the switch circuit at the connector end. Sharp end leads will be useful here although stiff wire and alligator clips work as well. When pressing the switch, the resistance should read less than .4 ohm. If there is as much as .5 ohm, the light pen won't read properly. So the desired resistance is .4 ohm or less (.2 ohm is preferred). This is why checking the switch in the game in test mode was never suggested as a step in the diagnosis process. In test, the game will show a functional switch even if the resistance is much higher than is actually acceptable so this built in test is useless for checking this switch.

If the reading is higher than .4 ohm, check to see that the wires are in the connector properly. Check again. If the reading is still high, check at the legs of the switch to see if there is a wire that needs to be replaced. If the connector and wires are all right, replace the switch. Desolder the wires and discard the old switch. It is easiest to use a small parts holding device for the process. A vice will do if necessary but be careful not to overtighten. Because of the tight fit of the switch in the upper insert, solder the wires on the inside of the legs. Solder carefully as too much heat will destroy this switch more easily than expected. Connect one wire to the common leg



tor.

under the button and one wire to the normally open leg on other end. Carefully bend these legs slightly in to make them fit into the confined area inside the upper insert. Test the resistance again. If everything reads all right and there is good light in the fiber optic, it's time for re-assembly.

Slide the pen end of the fiber optic and wires back into the armored cable. Seat the micro mini snap switch into the cutouts on the upper insert. Align the groove in the end of the armored cable to the roll pin. Seat the switch actuator in the upper insert so that the small leg of the actuator covers the push button portion of the snap switch. The actuator will probably fall out during re-assembly but do this step anyway to get a feel for how it fits. Seat the modified fiber optic connector into the lower insert.

This is where it gets a bit tricky and takes some practice. Carefully place the two inserts together. With a bit of effort, they will go back in place. It may be easier to remove the switch actuator until the inserts are united. Then the actuator can be fed through the hole it fits in while holding the inserts slightly separated. Try both ways to discover your own preference. Once together, a small piece of cellophane tape will hold everything in place.

Press the actuator several times. It should feel free and snap right back when you let go. If not, find where it's binding. Hold the insert unit with the fiber optic straight up. Slide the spring and light pen actuator tip over the fiber optic and down to the switch actuator. Now slide the Keno pen housing down over the tip and inserts. Line up the locking arms of the inserts with the cutouts in the housing and press together. You should now have a fully functional Keno light pen. Press the tip to be sure it isn't binding. Light test the fiber optic for brightness. VOM the switch for .4 ohm or less resistance and mark it "good" and put it in the appropriate cabinet.

It may not go so easy the first time but with practice, it should take ten to twenty minutes per light pen.

Here is a list of IGT's most recent updated part numbers for many of the most used parts in Keno light pen repair.

Pete Bachran
pbachran@slot-techs.com

INSERT-LIGHT PEN, UPPER	P/N	58420900
INSERT-LIGHT PEN, LOWER	P/N	58421000
ACTUATOR, TIP, LIGHT PEN	P/N	57102900
SPRING,COMP,.46 IDX.910LX.022W	P/N	33104100
PIN,ROLL,.063 ODX.438LG STL	P/N	44102390

SWITCH, SNAP ACTION, MINI MICRO P/N

SDS Reports - Part II

By Mike Thomas

In last month's article, I showed you the basics to setting up an SDS spec file. I explained some of the benefits to using these spec files and the theory behind the spec file components. This month I would like to get "down to business" and apply everything I talked about directly to the floor. By doing this, I am going to show you some spec file examples for fine tuning your bill validator maintenance.

We all know how important bill validator maintenance has become. Certainly, this trend is only going to increase as long as a casino guest always uses dollar bills. I remember when the bill validators were first being introduced. Then, much of the public preferred actually dropping coins in the game. Now that several years have passed, everyone has become spoiled on the idea of playing from credits and appalled at the possibility of actually handling coins.

I don't care how many years of experience you have with bill validators. If you have some BVs on the floor that are not working, all of the troubleshooting skills in the world will not help you. When approaching BV maintenance, many techs will walk the floor and look for BV faceplates that are not illuminated. These are the ones that get targeted for repair but while you are headed to that machine, you unknowingly pass five or six BVs that have not accepted a bill in two weeks. Sometimes you are called to a game that will suck in a bill, only to reject it and throw it back out. When this happens, you're given the opportunity to replace or calibrate the unit (depending on the model type) and, if necessary, send a faulty BV head to the shop for repair. This BV may have existed on your floor in this condition for several weeks or even a month but has gone unnoticed. Many times your floor attendants are too busy to call a tech. They pass this faulty BV off by explaining to the player "it must be full" or "I'll get someone to look at it" and never remember to call anyone.

The solution to this problem

```
REPORT NAME IS: " No Bills Accepted in Day Report"
HEADER "Asset Stand Denom Tech Initials Problem / Fix"
EXCLUDE ALL
INCLUDE IF SLOT STATUS = "on"
EXCLUDE IF SDS BILL TOTAL DAY > 0
EXCLUDE IF SLOT NUMBER < 900
EXCLUDE IF SLOT NUMBER > 9999
SORT ON STAND NUMBER
PRINT SLOT NUMBER, STAND NUMBER, DENOMINATION
PRINT "Tech _____ Prob _____"
END
```

The resulting report will look similar to:

"No Bills Accepted in Day Report"

Asset	Stand	Denom	Tech Initials	Problem / Fix
1652	1AA02	0.05	Tech _____	Prob _____
2299	1AB05	0.25	Tech _____	Prob _____
4384	1DA35	0.05	Tech _____	Prob _____

3 SLOTS IN REPORT

Note: ({# slots in report / total slots on floor with a BV} / 100 = BV operational status percentage)

is entering and running a report in SDS that tells you which BVs haven't accepted a bill or have accepted only a few bills in the last day, three days, week or month. One of these reports should be the standard against which you hold the quality of your BV maintenance program. Let's start with the basic structure of your spec file. Please note that there are two lines in my spec file which define the range of machine numbers in the report. You will see that you will have some games appear on the report which do not actually exist. There are fictitious games in the SDS system and you will need to consider ways to omit them. In this case, I know that any game with an asset number below 900 and above 9999 does not exist on my floor.

I am hoping all of you on SDS have access the SDS schema file. The schema file provides you with the field characteristics, which you can use in the report generator. The schema file is simply a listing of all the available fields for which you can build a report. If you look in line 5 of my spec file, you will see the phrase "SDS BILL TOTAL DAY." This is a field from the schema file which, as appropriately stated, reports the number of bills metered to SDS in the previous day. In the schema file you also will find the field names such as "SDS BILL TOTAL WTD" which is total bills for the week or "SDS BILL TOTAL MTD" which will be your bill totals for the month. Your goal should be, of course, to minimize the number of slots appearing on report and, by all means, to not have a single slot appear on the monthly report.

One more example to consider: What if you wanted to find machines that have not accepted a coin in a specified period. All you would have to do is omit "SDS BILL TOTAL DAY" and replace it with "COIN IN DAY." To further demonstrate the flexibility of the system, I will display a report that uses some of the GMU generated exception codes. The spec file below will display a report which shows all machines that have generated a code 68 (bill cassette is jammed).

One last example for your bill validator maintenance program is to show how you can find unseated cash boxes on the floor. You will use the same spec file as above, however you will omit the line asking for XC68 and replace it with the following two lines.

INCLUDE IF XC96 < 1
INCLUDE IF XC97 < 1

Exception 96 and 97 are "bill cassette door opened" and "bill cassette door closed" respectively.

As you can see, these spec files can be very helpful. If you examine the list of GMU generated codes and your field names in the Schema file, these are the only limits to the troubleshooting questions you can ask and ways you can increase your BV maintenance program's efficiency. This area of slot-tech work can be very frustrating and very challenging. Once you grasp these concepts of using your player tracking system, it can be very fulfilling as well.

In these last two months, I have mentioned several of the basics behind using these spec files. There is still a lot of work ahead for you to master the techniques. This presents a great opportunity for you to make a difference at your casino. After all, if you're not making a difference, then you're just taking up space. Good luck to you and remember to stay positive and never stop learning.

```
REPORT NAME IS: "Jammed Cash Boxes"
HEADER "Asset Stand  Denom  Tech Initials  Problem / Fix"
EXCLUDE ALL
INCLUDE IF XC68 > 1
EXCLUDE IF SLOT NUMBER < 900
EXCLUDE IF SLOT NUMBER > 9999
SORT ON STAND NUMBER
PRINT SLOT NUMBER, STAND NUMBER, DENOMINATION
PRINT "Tech _____  Prob _____"
END
```

- Mike Thomas
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Understanding Coin Hoppers - Part IV

By Frank Sutter

Last month I set the goal of trying to cover escalators and then finish with the rest of hoppers. I simply couldn't fit it all in, so this month, I'm going to give it another try. I talked at some length about clearing escalator jams last month, so now its time to go over some restoration techniques for damaged escalators.

It's true that very occasionally, escalators can get damaged in the course of normal usage. Much more commonly, however, damage occurs during the repair process. The source of the damage matters very little however, because it is far less relevant then the fact that it can be repaired. In most cases, there are ways to restore full functional usage. Since this is what we do, let's talk about how.

Burrs and irregularities in the coin channel will sometimes still allow the unit to function. In the cases where they interfere with normal operation, they can be smoothed out. The first level of repair involves burnishing the damaged area with abrasive cloth or steel wool. If this doesn't get the work piece smooth enough, the next level of repair involves polishing the damaged area with a hand-held rotary tool and a wire wheel attachment. If this still hasn't repaired the escalator, before you throw it away, try a grinding wheel attachment in the hand-held rotary tool. This technique may possibly make dramatic changes to the surface, so I will only use it if this represents the last chance to rescue the unit from the scrap heap.

The edges of the coin channel can sometimes get compressed or flared, and this damage sometimes occurs in normal usage. For example, when coins double in the channel, the channel will be widened just like the exit chute gets widened. This damage can readily be repaired if you can find just the right thickness jig with which to repair it. Coin channels come in different widths and the clearance with the traveling coins must be maintained. My advice is to put the correct thickness piece of metal in the flared channel as a jig and put the work piece into a vice. Then, gently clamp down on the coin channel at the widened point just until it straightens and no further. Use the jig inside the coin channel as a guide, not as a stop. In other words, if you have to struggle to get the jig out, you squeezed it too tightly.

The most common problem in escalators (and the one that rarely gets attention) is dirt. It stands to reason that anything that increases the resistance to coin motion in the escalator column will also increase the likelihood that a jam will occur. It also stands to reason that dirt begins to build up with the first usage of the escalator. Despite these obvious facts, however, the reality is that it takes a whole lot of dirt to actually interfere with the normal operation of the escalator, so most technicians prefer to skip over the through cleaning step. Nonetheless, if you find yourself in the position of removing one of these units from the game and disassembling it, it wouldn't hurt to give it a thorough cleaning before you reassemble.

This would seem easy enough using a foaming cleaning spray, a wire brush and towels but the inside of the coin channel (where the important dirt actually is) can be difficult to get at. I picked up a tip from reading a magazine article on slot machine repair some time ago and it has worked pretty well. By breaking an old, used hacksaw blade in half, and grinding the broken surface square, I obtained a tool which could reach the inside of that coin channel. If you try this, cover the squared end of the blade with a thin piece of cloth and use it to scrub the dirt from the inside edges of the coin channel.

Once in a while, you'll get a hopper that is jammed but you can't see a problem with it. This condition can mean several things. I have already mentioned one of them. If the coin count switch is not counting coins, the machine will sense it through its software. Basically, the instructions tell the CPU to turn on the hopper, monitor the coin-count switch signal and count the pulses until the number of pulses equals the total pay out amount. Then it shuts the hopper down. However, if there is no activity on the count switch line for a few seconds after the hopper has been turned on, the CPU will shut the hopper off and report a fault. If this is the case, you will find no jam when you open the game.

If you check the count switch and find that it is operating properly, it is likely that you have found one of three things: You may be facing a frozen pinwheel, a free pinwheel, or a failed motor. None of these are good because they all involve complete disassembly of the hopper.

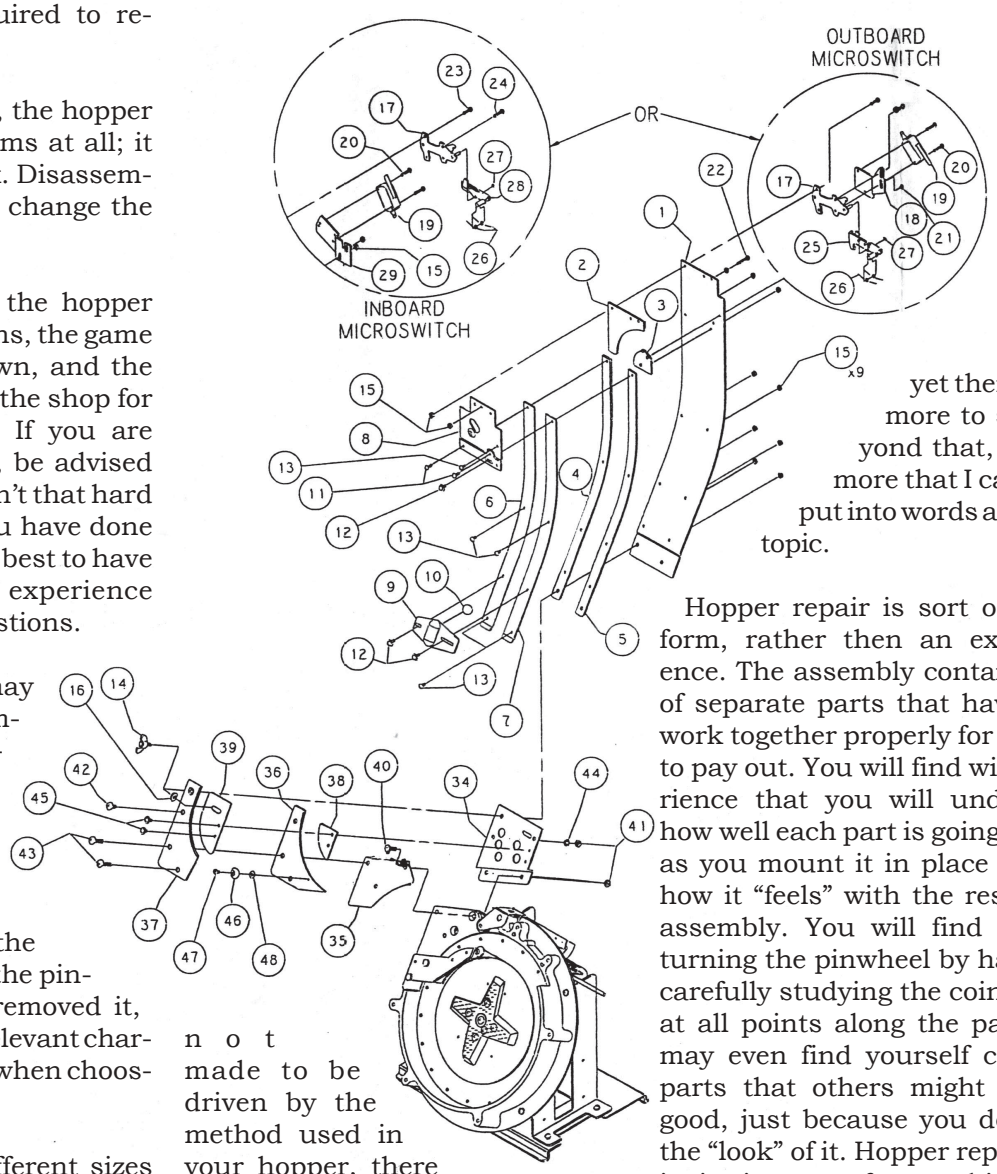
First, the free pinwheel. In general, the mechanism that applies the torque from the motor to the pinwheel has snapped. This means that the motor is turning but it no longer drives anything. In this case, you can hear the motor turn on, but the pinwheel will not move. Disassembly will be required to repair the drive mechanism.

In the case of the frozen pinwheel, something is impeding the motion of the pinwheel. Since it isn't to be found in the front, it must be behind. Most of the time, the pin-

wheel will refuse to budge, almost as if the brake were engaged. Disassembly will be required to remove the debris.

If the motor has failed, the hopper won't have any problems at all; it just isn't going to work. Disassembly will be required to change the motor.

In all of these cases, the hopper must be emptied of coins, the game signed off and left down, and the hopper transported to the shop for more extensive work. If you are new to the profession, be advised that while hoppers aren't that hard to take apart, until you have done it a couple of times, it's best to have someone with more experience around to answer questions.



Another reason you may find yourself disassembling a hopper is for pinwheel replacement. This may happen because the pins have been worn round from turning in the coins. Once you have taken the hopper apart down to the pinwheel and you have removed it, you need to know the relevant characteristics to consider when choosing a replacement.

Pinwheels come in different sizes and types, and the proper replacement part is important for proper hopper operation. Important is not the same thing as essential, because I myself have seen hoppers work with the wrong pinwheel installed. There is no doubt however, that it leads to more frequent jamming and is not recommended. The most important characteristic to match is the number of pins on the pinwheel. After that, the edge of the pinwheel will have to match, because some have a ridge along the outer edge to ride in groove in the edge bearings while others do not. The last important characteristic is the type of drive the pinwheel employs. These drive methods are not interchangeable and there is no other choice but to use an exact match. If the pinwheel is not made to be driven by the method used in your hopper, there is no technique I know of to adapt it and make it work.

Here's a little tip I learned a long time ago, then proceed to ignore from time to time and kick myself in the butt for not remembering it. When you reassemble any one part, remember to start all the screws before tightening any of them down. It sounds simple enough, but I wish I had a five dollar bill for every time I started the screws, then ran them all the way in without thinking, Most of the time, you just can't get the last screw to line up with its hole.

I have covered a lot of ground in this series of articles on hopper repair. I think I touched on most of the basics in this diverse topic and yet there is still more to say. Beyond that, there is more that I can never put into words about the topic.

Hopper repair is sort of an art form, rather then an exact science. The assembly contains a lot of separate parts that have to all work together properly for the unit to pay out. You will find with experience that you will understand how well each part is going to work as you mount it in place and see how it "feels" with the rest of the assembly. You will find yourself turning the pinwheel by hand and carefully studying the coin motion at all points along the path. You may even find yourself changing parts that others might say are good, just because you don't like the "look" of it. Hopper repair is an invitation to craftsmanship. To me it's a point of pride to walk away from a jammed hopper that I repaired and have it work properly for the rest of my shift. If it jammed again, I would take it very personally.

I started this series with a small blurb on the basics, and how it's important for the real professional to execute the fundamentals of his profession effectively. Although I still believe that this job is fundamental to the profession, the depth of the topic surprised even me. Hopper repair is a job you will perform often and I hope that you take the care to perform it well.

'Till next time, keep 'em runnin'!

Frank Sutter
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Sencore Blows Away CRT Failures With CR7000

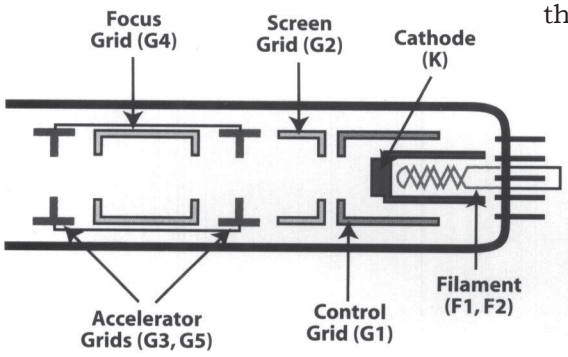
- Also, How CRTs Fail

I got the call again today. It comes about once a week now. It goes something like this:

"I can't adjust the color on this monitor. It looks real dim. If I try to turn up the pots on the neck board, the picture just smears to the right. If I try to turn up the brightness on the remote adjustments board, the picture smears to the right. If I try to turn up the contrast, the picture smears to the right. I have the screen pot turned up as high as it can go without seeing raster and vertical retrace lines washing over the whole screen."

Then, as if a sudden revelation has come over the caller, he perks up and queries "Hey! Could it be a bad picture tube?"

The answer, of course, is "Yes." To verify, I ask the age of the CRT. After three or more years in operation, many CRTs begin to fail. With so many CRTs in the world today, the ability to test and repair (yes, repair!) CRTs can be pretty darned handy. Testing and repairing CRTs will save you time and money.



The electron gun is the source of most CRT failures

But how can you fix a bad picture tube and what the heck fails, anyway? Those are good questions! As video slots are on 24/7, they can easily log tens of thousands of hours of operation. As a result, picture tube or CRT (cathode ray tube) failure has become increasingly more common.

Anyway, the answer to the question is yes. Sometimes Kinda Sorta. Maybe. But before we get into repairing picture tubes, let's take a look at some different types of picture tube failures. More specifically, we're going to look at the electron gun assembly that's located in the neck of the picture tube.

Each of the three electron guns in the electron gun assembly uses a heated cathode as a source of electrons. The heater is the element that you see glowing when you look at the neck of a picture tube. The heater must fit closely inside the metal cathode but it must not touch it. If the heater shorts to the cathode, the gun will be stuck "ON" and the screen will appear a super bright color (red, green or blue depending on which of the three guns is affected) with vertical retrace lines visible throughout the screen. Vertical retrace lines appear as diagonal lines that run from lower left to upper right across the screen.

If you believe you might have a heater-to-cathode short, try unsoldering and removing the associated video output transistor from the neck board of the monitor. Fire up the monitor with the transistor removed. If you still have a brightly colored screen with vertical retrace lines, there's a good chance the CRT has a heater-to-cathode short.

You should be able to verify this with an ohmmeter. With the neck board removed From the CRT, you should have an infinite resistance between heater and cathode of the picture tube .

Although there are many different types of CRTs, you will often find the red cathode at pin 8, the green cathode at pin 6 and the blue cathode at pin 11. Pins 9 and 10 are for the heater.

It is also possible that one of the cathodes might become shorted to the control grid. This can cause a similar symptom as a heater-to-cathode short. If the cathode is shorted to the control grid, you should be able to verify it with your meter. The control grid will often be found at pin 5.

If the cathode has become damaged due to a buildup of oxides and other crude, you will experience a loss of one color (partial or total.) Try grounding the collector of the associated video output transistor. If the color comes on clear and bright (a brightly colored screen with vertical retrace lines) the CRT is okay. If the color does not come on or it is not as bright as the other two colors, the picture tube is bad.

Another type of electron gun failure is a short between the control grid and the screen grid. This will cause an extremely dark picture (even with the screen control at maximum) or no picture at all.

Measure the voltage at the screen grid (often pin 7) of the CRT. You should be able to run it through a range of 250 to 750 volts DC using the screen potentiometer. If the voltage is not high enough, pull the neck board off the CRT and measure the voltage at the CRT socket again. If the voltage is now normal, you probably have a short between the control grid and the screen grid. Use your ohmmeter to verify.

FIXING BAD TUBES

Is it really possible to fix a bad CRT? I have had a fair bit of success using some simple techniques. Shorted electron guns are often caused by small flakes of cathode material that have sloughed off and found their way into the electron gun. This type of failure is common in games with face-up mounted monitors (table games, gun games that use mirrors. etc.) because any crud in the CRT will naturally fall right into the electron gun. By turning the picture tube face down and tapping lightly and repeatedly on the neck with the plastic handle of a screwdriver, the flakes can sometimes be dislodged.

Do not hit the convergence ring assembly and for goodness sake don't hit the glass neck hard enough to break it! Naturally if you manage to shake the shorting particle out of the neck of the CRT, you do not want to use this picture tube for a table game again, EVER!

There is another trick that you can use to save a shorted CRT. Commercial CRT service equipment uses a technique known as "rejuvenation" to remove shorts from electron guns. The rejuvenating circuit uses a capacitive discharge to blow away any little shorting particle. We'll look at the CRT rejuvenator later but here's a cheap and dirty way to repair some shorted CRTs using just a clip lead or small piece of wire.

CAUTION: The procedures described herein involve potentially lethal voltages and must be performed by qualified personnel or at the very least by a mechanic with a decent sense of self-preservation.

1. Remove the video output transistor associated with the bad color. If in doubt, remove all three video output transistors. I usually remove all three just to be sure.

2. Locate the screen voltage pin of the CRT socket (often pin 7 but check schematic to be sure.) This pin is often labeled "G2."

3. With the neck board installed on the CRT (without the video output transistors installed) turn on the monitor and adjust the screen potentiometer fully clockwise in order to obtain maximum screen voltage.

4. Touch one end of a wire or clip lead to the screen voltage pin of the CRT socket.

5. Momentarily touch the other end of the wire to the shorted cath-

ode pin (red, green or blue) of the picture tube. With luck, you will see a small blue arc in the neck of the CRT as the short is blown away.

6. Use your digital multimeter to verify that the short is gone. You should now read an infinite resistance. If not, repeat steps 1-6.

Cathode to grid shorts and grid to grid shorts can often be removed with this technique. Heater to cathode shorts are another story as the thin filament of the heater can blow out before the short circuit does. I have had about 25% success removing heater to cathode shorts this way.

THE RIGHT WAY TO TEST AND RESTORE CRTs

Now let's look at the "correct" way to test and restore CRTs using a remarkable piece of test equipment, the CR7000 "BeamRite" CRT Analyzer and Restorer. Before I begin to describe what the BeamRite does and how it works, let me say that I have repaired and restored dozens of bad video game picture tubes using the predecessor to the CR7000, the CR70. I have taken old CRTs that were dim and virtually unusable and turned them into beautiful, bright displays that look as good as the day they were manufactured. In the process, I have saved operators and Arcade School students hundreds of dollars in CRT replacement costs. I saved $400 just by restoring one high resolution CRT!

What is it?

First of all. Sencore's CR7000 BeamRite will test all types of picture tubes. Individual tests are made for short circuits in each of the three electron guns. Tests are made for heater-to-cathode (H-K) shorts and cathode-to-grid (G1) shorts as well. The electron guns are also tested for proper cutoff (the level at which the gun stops emitting electrons, producing black on the screen) and "emission" (sufficient beam current to produce a bright color on the screen).

Each of the tests closely duplicates the normal operation of the CRT so you're testing it under typical operating conditions. By the way, you do not need the entire monitor in order to test the picture tube. The CR7000 will test any CRT as a stand-alone unit. Naturally, you do not need to remove the picture tube from the monitor to test it. You simply remove the CRT socket (the neck board) from the monitor in order to connect the picture tube to the BeamRite. The CR7000 comes with adapter sockets for testing all types of picture tubes. Notice I didn't say "most picture tubes" or "all popular tubes." The BeamRite tests 'em all!

Another test checks the "tracking" of the three color guns. In order to produce a picture that is properly color balanced, all three electron guns have to be alike. The emission levels of all three guns are compared by the CR7000. which measures the ratio between the strongest and weakest gun. If the difference is more than 55 per cent. the gun will show as "bad." Don't worry! Bad guns can be restored by the BeamRite as we'll see later. The CR7000 BeamRite even has a "life test." The life test will tell you how much usable life you call expect from your picture tube.

REMOVING SHORTS

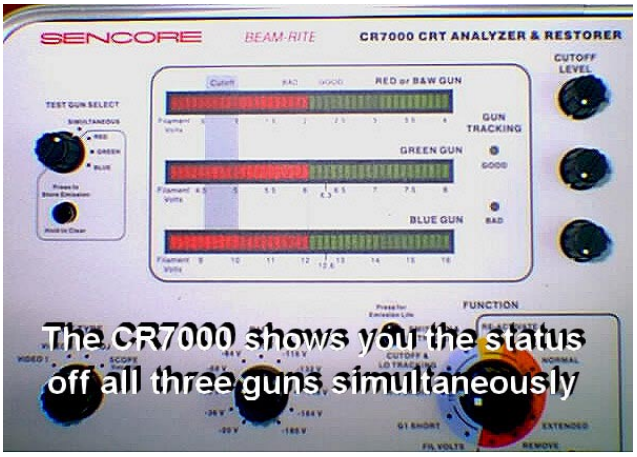
Heater-to-cathode shorts are caused by contact between the CRT heater and the cathode. The CR7000 is not designed to correct this fault as the surge current provided by the BeamRite will often blow out the filament completely.

Control grid (G1)shorts are often caused by flakes of material that have become lodged between the cathode and the control grid. A G1 short can cause loss of control of the CRT beam, resulting in a bright screen with visible retrace lines.

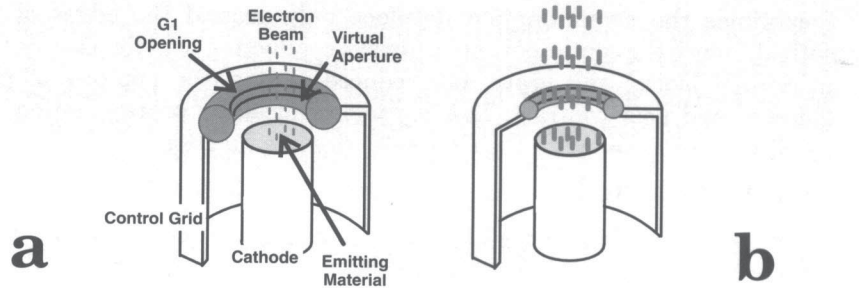
G1 shorts also result in CRTs that cannot be controlled by the brightness control or the incoming video or blanking signals. The CR7000 "REMOVE G1 SHORT" function will vaporize most shorting particles, resulting in normal CRT operation.

CUTOFF RELATED FAILURES

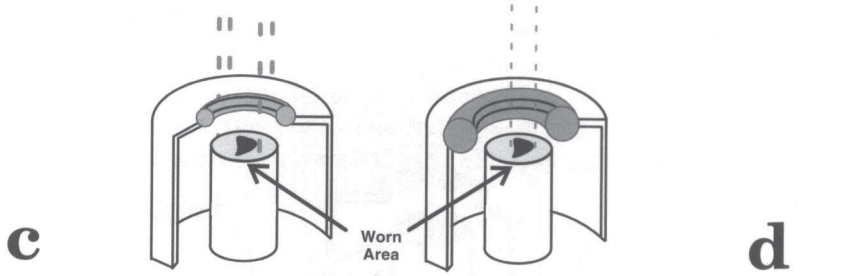
In order to understand the cutoff test, let's take a closer look at the way the cathode works. The cathode is the source of the electron beam. It is coated with a material (such as barium or thorium) which gives off large numbers of electrons when it is heated by a filament. Believe it or not. there is a finite amount of this electron emitting material and it gets used up or "stripped" after years of extended use. Once the barium is used up, the picture tube cannot be completely restored.



The hot cathode emits electrons which form a cloud around the cathode until they're attracted toward the front of the screen by a positive voltage on the screen grid of the electron gun assembly. Between the cathode and the screen grid lies the control grid. In most video game monitors, the control grid is grounded, giving the control grid a negative bias with respect to the cathode. The video signal modulates (changes) the voltage of the cathode. It is the voltage difference between the cathode and the control grid that controls the beam



Only a small portion of the cathode emits electrons when high G1 Bias closes the virtual aperture (a). Reducing the bias results in more beam current because more of the cathode's surface emits electrons. (b)



Bad Cathode / High Bias **Bad Cathode / Low Bias**

continued - A CRT with a worn cathode center area (c) still produces good light output at low bias, but cuts off far too soon at higher biases (d).

current and the brightness of the color.

The entire surface of the cathode is not always used to supply the electrons that make up the electron beam. When the electron gun is only partially turned on, just the center part of the cathode is used. This means that the emitting material at the center of the cathode is used up faster than the material at the edges. The outer areas only supply electrons during peak brightness periods. When the center part becomes worn, the CRT screen still lights brightly during peak brightness but the beam cuts off too soon because the brightness drops and the worn-out center of the cathode is the only part being used. This results in a picture that's a combination of over-driven, smearing color and black, with no intermediate shades of color. Many technicians call this a "gassy" tube. Actually, the tube is exhibiting poor gamma; the ability to correctly reproduce shades of gray or color.

The CR7000 tests for proper cutoff. The cutoff test, combined with the emission test that follows, indicate the next steps to be taken in the restoration process.

EMISSION TEST

The emission test indicates if the edges of the cathode are poisoned. Poisoning occurs when positive ions coat the emitting material on the cathode. The ions are a result of a minute amount of air that's left inside the CRT during manufacturing. These ions react with the hot cathode surface over a period of time and reduce (in some cases completely shut off) the number of electrons emitted by the CRT. Cathode poisoning is similar to rust on a piece of steel.

If the tube fails both the emission test and the cutoff test, the entire surface is poisoned or stripped of emitting material. An emission life test reduces the filament voltage to detect cathodes that are overly temperature dependent, indicating short life expectancy.

CRT REJUVENATION AND RESTORATION

The CR7000 uses a number of different methods to fix picture tubes. The method used varies from tube to tube, depending on the nature of the CRT failure. The BeamRite uses a "progressive restoration" technique that allows you to carry out CRT restoration one step at a time, using just the right combination of voltage, current and heater voltage to get the job done while avoiding the tendency to "overdo it" that many technicians have when restoring a CRT. The process of restoring a CRT is often referred to as "shooting the tube."

After removing any shorts and testing each gun for cutoff and emission, you're ready to try restoring any weak guns. The CR7000 does this by boosting the CRT heater voltage. This makes the cathode super hot. Then, a 40 to 100 milliamp current is passed through the cathode. The combination of high temperature and high cathode current removes the cathode poisoning, exposing fresh cathode material.

Restoration

The CR7000 "BEAM-RITE" offers four automatic CRT "Restore" functions to return near normal performance to the CRT cathode. The four functions are progressive levels of current and current durations including Low, Normal, High, and Extended. Progressive restoration allows you to use only what the gun needs to restore its operation.

* Re-activate 30 sec. (1 mA) * Low - 2 sec. (40 mA) * Normal - 2 cycles (80 mA) * High - 3 cycles (100 mA) * Extended - 15 sec. (100 mA)

Re-activate The CR7000 "Re-activate" function safely activates the existing cathode emitting material with little or no threat to the CRT gun. Re-activation also works well on some CRT guns that have aged causing minor cathode contamination or poisoning. You can use the Re-activate function repeatedly with little threat of damaging the CRT cathode.

The Low Restore function uses a brief two second current, limited to 40 mA, to heal the contaminated cathode surface. The Low Restore function uses a much lower current and shorter current duration than offered by any other CRT tester On many weak cathodes, this is enough to be effective while eliminating the cathode damage that would result from other testers and higher levels of restore currents.

The Normal Restore function offers additional restore current, limited to 80 mA, and two automatic cycles lasting three seconds each. The higher current and duration removes the contamination more aggressively from the cathode while permitting a three second pause between current cycles. The High Restore functions boost the filament voltage to superheat the cathode while increasing the maximum current to 100 mA. The High Restore function is effective in removing thicker cathode contamination. For tougher cathode contamination, the Extended Function draws continuous restore current up to 15 seconds.

This has worked like a charm every time I've used it.

If you cannot get any cathode current to flow due to complete poisoning of the cathode, the CR7000 has a "rejuvenate" function. The rejuvenate function is used when the CRT cathode is so totally encrusted that no restore current can be drawn by any of the other restore functions.

In the rejuvenate function. a charged capacitor is connected between the cathode and the control grid (G1). When the sudden positive voltage from the capacitor is applied to G1, the electrons under the poison crust break free, essentially cracking the layer of contamination. Once the layer of contamination has been cracked, the other restore functions can be used successfully.

Other CRT Gun Problems and Tests

G1 & H-K Short Tests When testing a color CRT gun, the G1 Short and H-K Short tests are performed simultaneously on the red, green, and blue electron guns. The three-bar graph display indicates the resistance of the respective guns simultaneously. You know at a glance if any of the color guns has an inter-element short.

G1 Shorts Test These common shorts are automatically tested with the CR7000 and the display shows which elements have the short.

In the "Remove G1 Short" function, the cathode (K) and G2 grids are connected together. The filament voltage is removed to cool the cathode and prevent filament or cathode damage. After a delay, pressing the "Press To Restore" button discharges a 350 volt capacitor through the short path between the G1 and the K/G2 connection.

Cutoff Test The CR7000 simulates cutoff bias conditions relating to the manufacturer's specified range and circuit bias conditions.

Lo Tracking The Lo Tracking test compares the level of' G2 voltage needed by each gun to produce cutoff current. It is automatically

performed while testing cutoff of all three guns of a color CRT. The "Good" GUN TRACKING LED lights when all three guns are conducting within the "Cutoff" area of the display and the G2 voltages are within a ratio of 1.25:1.

Emission Test First, the CR7000 measures "true beam" current or the current passing from the cathode through the opening in G1 and on to G2. This provides the best representation of the actual CRT beam current that strikes the phosphor screen. A second and exclusive feature of the CR7000 is a "sliding" Good/Bad scale for testing emission to manufacturer specifications.

The CR7000's Emission Life Test cools the cathodes slightly by decreasing the filament voltage by 25%. A cooled cathode produces less emission, but most good cathodes are capable of producing more current than is needed for full beam current (white picture level).

Hi Tracking

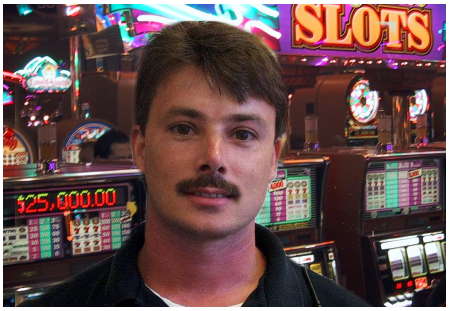
The CR7000's Hi Tracking test compares the peak emission levels of each gun of the color CRT. The Hi Tracking test automatically calculates the tracking ratio as it simultaneously displays the emission readings for all three guns. The "Good" GUN TRACKING LED lights when all three guns have emission currents resulting in a ratio within 1.55:1.

FREE CD-ROM

A very informative CD-ROM on CRT failures is available from Sencore. Just ask for the CR7000 CD-ROM. It's free. Sencore's toll-free number is (800)SENCORE. The address is 3200 Sencore Drive, Sioux Falls, SD 57107. They have a website at http://www.sencore.com. Ask to be put on their mailing list and you'll receive a free subscription to Sencore's technical newsletter on troubleshooting monitors and VCRs. Please tell them Slot Tech Magazine recommended you call.

Ordinary Man

By John Green



A while back, I was supervising grave shift and was called for customer assistance. I think to myself that I'm not looking forward to yet another dispute but as Frank Sutter said, that's why we make the big bucks.

After arriving at the scene of the crime, I sized up the mood of the customer who was wearing jeans, T-shirt and ball cap; a nice older gentleman. He stated that he put in a $100 bill and noticed that the monitor was not centered under the touchscreen. He grabbed a slot tech that happened to be walking by and asked him to take a look at it.

After repairs, he stated the slot tech had closed the game and that there were no credits. I'm thinking, why is it always a $100 bill? Anyway, I checked the validator and then the bill history, which showed that the last three bills were $100s, so pulling the box would do no good.

I asked if the bill possibly fell onto the floor, but none was to be found. I asked if he possibly played it in another game and to my surprise, he pulled out a log that he keeps of all bills, wins and machine numbers. Pretty odd I thought, but sure enough, he had written that he had put in the $100.

Hmmm... what happened here? I explained that I'm was going to check the surveillance tape (sometimes just a stall tactic) and that I would be right back. I also explained that it was ok to continue playing the game. I grabbed his players card and called a floor manager to check his play.

Ouch! This ordinary looking guy had 2.5 million in handle. I went to the cage, got a crisp new $100 bill and rushed back to him, pushing little ole ladies to the ground and jumping over an ever-so-slow walking floor attendant (ok, I exaggerated). I stated that I wasn't sure what happened but we were happy to reimburse him for his trouble. I gave him my name and explained if he had any more trouble to call me. After several minutes of convincing, he finally accepted the bill. Several hours later I found him again and asked if he had any more troubles and we talked about life for a minute.

I think what I'm trying to say is that you should treat every customer as if they are the ones playing 2.5 million in handle. You can't tell by appearances. It is just good policy and keeps everyone happy. Frank Sutter was right on the money with his article "The Ambassador, the Slot Tech and You" (Slot Tech Magazine, April, 2001). With his permission, it should be incorporated into every casino's new hire reading.

- John Green
jgreen@slot-techs.com

You do not know anything about this player

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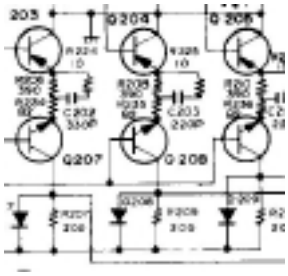
ELECTRONIC COMPONENTS

The individual components used in games are introduced. Parts such as resistors, capacitors, diodes, potentiometers and transistors are covered individually. Students learn how the components work and how to test them using the meter.

SCHEMATIC DIAGRAMS

Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



POWER SUPPLIES

Power supply failure is a common complaint in many different types of systems.. Power supply failures are discussed during the class, along with shortcuts for troubleshooting and repairing them.

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The monitors used in video slots are designed for quick, easy, and safe repair. Students will learn the theory of operation of all types of monitors and how to repair monitors down to the component level. Of course, monitor safety will also be discussed.

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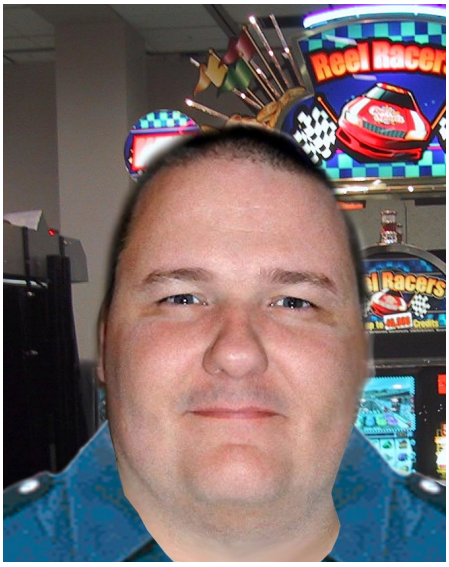
On the Job

So what's he been doing since graduating?!?

By Scott Reynolds



Hi everyone. Since my first article appeared in this past April's Slot Tech Magazine, I have been itching to write another one but really didn't have enough for an article until now. I wanted to let you know how things are going since graduation.

When I finished Slot School at the Green Valley School of Gaming here in Las Vegas, I was really eager to get started but unfortunately, things were kind of slow in the hiring department. I went on many interviews and had many callbacks, but each time, I received a polite rejection letter or worse, no word at all. I think the most valuable lesson I've learned while looking for work out here in the west is: don't give up! When you submit an application, it often takes two weeks (or more) to get an actual interview; usually another week to get a callback and still another week to actually get hired or receive a rejection letter.

When I finally was hired, it was to Mermaids Casino on Fremont Street. Now if you are not familiar with this casino, that's because it hasn't been around that long. It used to be "Sassy Sally's"; their sister casino, "La Bayou" (where I also worked at the time), is across the street, and was formerly known as the "Coin Castle". Both casinos have undergone makeovers since their name changes. As these casinos are so small, the slot techs did a little of everything, including fills and custodial work.

My day started at 7am and included either preventative maintenance of machines or sorting, counting and bagging coins with a Jetsort machine. The casinos opened their doors at 10am and from then on, unless there was a problem such as a hopper jam or stuck bill, I wiped down machines and helped keep the place straightened up. I worked at Mermaids for 4 days; it seems the fellow I was hired to replace wasn't leaving after all so I wasn't needed. It was actually good news to me, I don't think I could have taken another day of wiping fingerprints off of machines for 6 hours until quitting time.

My next job was with Alliance Gaming (also known as Bally's) in their quality assurance department. Here, it was my job (along with a very nice woman named Elfriede) to make sure that the games conformed to the sales order. Let me give you the rundown of what I did:

1. Plug in the machine and verify correct power up.
2. Make sure the unit had a hopper and/or ticket printer as specified in the order
3. Verify destination and that the machine conformed to local standards (for instance in some Peruvian casinos, the hopper must have a locking plate over the top so no one can get to the coins without a separate key).
4. Perform Input/Output tests on the switches and lights
5. Perform paytable test to make sure that the awards given match glass.
6. Insert a single bill of each denomination the machine accepts to verify the proper credits are issued and the bills are not rejected (larger bills than the machine should accept are also inserted to ensure that they ARE rejected).
7. Coin test machine and play several games to verify general working order.
8. Cash out or do a hopper ten pay test to verify correct hopper operation.
9. Shut down machine and send it down the line to be packed

I'm sure I may have left out a step or two as I haven't been there in over a month but you get the idea. I was with Bally for one week before getting a call from Boulder Station Casino whom I had applied with earlier. The job was slot clerk (in charge of the slot hard files). I gave Bally a second week and then went to work for Station Casinos.

Boulder Station (as with all Station Casinos) is a "Locals" casino meaning that they cater mainly to the repeat business of the locals rather than tourists. That is not to imply however that they would turn down tourist business but their properties are located off-strip and so unless the guest is looking specifically for them or staying in outlying areas, they may never set foot in one of these casinos. That's a pity because they really are great places to spend time in.

In case you are not familiar with what a slot file is, here is an explanation: Each slot machine must have a hard file or record of its existence. In this file is required a "Work History" an "EPROM Worksheet" and a "Par Sheet" for the particular game(s). The Work History details major events in the life of the machine such as moves on and off the floor, moves within the casino, chip changes and conversions. The EPROM Worksheet gives the details of the game chips including the library number, chip number, manufacturer, size and electronic signature. The par sheet is provided by the manufacturer

and not only gives the percentage or hold of the machine but lists every conceivable combination that can be hit and what the frequencies of those hits are.

These files are very important; if the Nevada Gaming Control Board comes in and demands to see the slot file for a particular machine or bank of machines, the information had better be correct and intact or the casino can be fined and in extreme cases, shut down until compliance is met.

My job is to keep these files up to date (and right now, completely redo each and every one). As I get to a machine, I do the following:

1. Open Machine and cut power.
2. Remove MPU Board and locate game chips.
3. Kobetron each game chip to get its unique signature.
4. Make note of the signature and other pertinent information on the EPROM Worksheet.
5. Make note that the par sheet is correct (if not, I can make a copy of the master sheets we keep in the slot office)
6. Reseat all chips and replace MPU board.
7. Power up machine.
8. Repeat with the remaining 3,000+ machines in the casino (Boulder Station has the second largest number of slot machines in Las Vegas, MGM has a few more, but boulder is planning an expansion next year that may put them over the top).

Now occasionally, I will have a problem when powering up the machine and will have to rely on what I've learned or ask one of the techs for help. I have noticed that about 1 in 6 Williams machines develop RAM errors after their boards are removed and reseated and a soft RAM clear must be done. This is not a major problem but annoying nonetheless and I am at a loss as to why it happens. I have also noticed that some IGT S-Plus slots go into a 61 error code (this is identified as a "Bad CMOS RAM" error according to their literature) when their chips have been removed and reseated. This is also an easy fix. Just hold the test button for 3 seconds and turn the reset key to clear (thanks Roy).

I have also caused a problem or two while doing this. My first week, I was working on Williams slant tops and instead of opening the main door and pulling the hopper out to get to the auxiliary outlet, I slid the hopper towards the front of the machine by ¼ - ½ inch and plugged my Kobetron machine in from the top hatch; Well, whenever a customer would try to cash out of one of those machines after I was finished, it would lock up. I found out later on that I was causing the error by not pushing the hopper back.

I have also, twice, reseated a chip either backward or improperly with a leg outside of the socket. The time I reseated the chip backward, the game would not come up and I found out that I corrupted the chip. I had to return to the shop and burn a new copy to replace the one I damaged. The improperly inserted chip caused a choppy video image. Once the chip was inserted properly, it worked fine.

I have a big job ahead of me but I have finally found a home and hopefully after I get the slot files caught up to date, I can become a utility tech and will have more to write about. Until then, may all your problems be small ones.

- Scott Reynolds
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