June, 2001

Inside This Month's Slot Tech Magazine

In the last of our three-part series on semiconductors, we take a look at a special type of transistor called a MOSFET. MOSFETs are used in low voltage power supplies as well as in the SMPS of video slot monitors. If you have a monitor or power supply that's blowing a fuse, you just might have a shorted MOSFET. How can you tell? Turn to page 4 and see.

Preventative maintenance is an important part of casino slot operations. Some of the sub-assemblies in a slot machine absolutely demand it. Bill validators are one obvious example. Neglect a bill validator and you can watch your acceptance rates drop like a rock. Replacing lamps, cleaning screens and reels and vacuuming out the inside of the machines are all important. It may be important for the operation of the machine. It may be important for the appearance of the machine. It may be simply that it's no fun working inside a machine that's covered in a quarter of an inch of nicotine laden dust.

For all these reasons and more, a slot operation needs to schedule these tasks and to assure that they are completed. Slot Tech Magazine contributing writer Frank Durso presents us with a couple of nifty forms that can be used to keep track of the jobs at hand. See PM Schedules and Logs starting on page 14.

This month's Slot Tech Opinion is on the subject of slot techs and skill levels. Can you quickly get to a problem, isolate it and repair it? Is it fun for you or do you struggle? How would you rate yourself in terms of your skill level? Read Mike Thomas' opinion on page 20. Replys are welcome and will be published in future issues of Slot Tech Magazine.

Randy Fromm

And speaking of bill validators and routine maintenance and stuff, Bart Holden has a knack for the practical side of this most important and oft-repeated repair. This article alone is worth the price of an annual subscription to Slot Tech Magazine. See for yourself by reading "Taking Bill Validator Repair to the Floor" beginning on page 22.

Of all the tests and measurements you can possibly name, none is more important to the art of monitor repair than measuring the B+ power supply. Find out why and where to take this vital voltage reading beginning on page 16.

Until next month, see you at the casino.

Randy Fromm

Randy Fromm

Randy Fromm's
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Introducing the MOSFET

In the April issue of Slot Tech Magazine, we spent quite a bit of time discussing transistors. We've discussed how transistors work, how they fail, how to test them with a meter to see if they're good or bad, and how to obtain replacment components.

The transistors we have discussed so far are technically known as "bipolar" transistors. Remember that they are made from type N (negative) and type P (positive) silicon. These two types of silicon are of opposite polarities. Two polarities - bi-polar.

Although a transistor can be used in a number of different ways in many different types of circuits, we have primarily looked at the transistor in its simplist operating mode, that of a simple switch. When a bipolar transistor is used as as a switch, its operation is simple. When the transistor is turned off, there is no connection between the collector and the emitter the transistor. When the transistor is turned on by applying a specific voltage to the base, the emitter and collector are connected together. The collector and the emitter are the "switchy" part of a transistor. That's where the main current flow (called the collector current) flows. When the transistor is on, those two leads are connected together.

Or are they? Well, not really. Not perfectly, anyway. In a bipolar transistor, there is always a little bit of voltage drop between the collecter and emitter, no matter how hard the transistor is turned on. It's called V_{ce} and it's around .2v in a bipolar transistor. Even when the transistor is fully turned on (a condition called "saturation") the collector and emitter leads are not perfectly connected together. There is always a .2v drop.

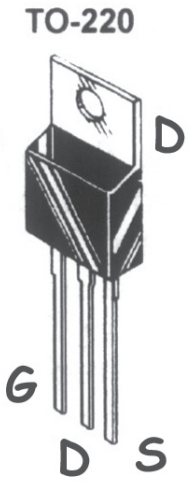
So what? What's the big deal? It's just two tenths of a volt, after all. Well, very often it isn't a big deal. We use bipolar transistors as switches in switching regulator power supplies in computers all the time. There's one on just about every desk in the world. The horizontal output transistor in a monitor is a bipolar transistor as well.

But this V_{ce} does present a couple of problems when we're trying to switch large amounts of current, very fast as we do in a modern switched mode power supply or SMPS. One problem is dissipation of excess heat. Let's try to do this without looking at the numbers but just as a general concept.

If there is a voltage drop, there must be a resistance at work here. That's Ohm's law. Watt's law tells us that if there is a voltage drop across a resistance, we must be dissipating power which, in this case, can only show up as heat. Since Watt's law states that the power in watts is equal to the resistance multiplied by the current, you can see that high current switching results in many watts of waste heat. That is, of course, why there is such a large heatsink mass for the switching transistors in a computer power supply and why the horizontal output transistor in a monitor is mounted on a large heatsink as well.

In addition to the excess heat generated by the presence of V_{ce}, there is another problem as well. The same resistance that generates heat also limits the speed of the device as well. As the transistor turns on, it takes a finite amount of time for the primary circuit to come up to "full power." Part of what determines that time is the resistance of the circuit. It's a simple formula, called an RC time constant. T=RC. That is, Time (in seconds) = Resistance (in ohms) X capacitance (in farads). That is not a misprint, by the way. That's

Fig. 1



A typical MOSFET in a TO-220 package

farad not microfarad. Remember that the unit of capacitance is actually the farad (named for Michael Faraday) and when we speak of microfarads, we are talking about millionths of a farad.

But where does the capacitance come from? There's no capacitor in the primary other than the main filter capacitor and that's actually a power supply for the primary circuit and has nothing to do with the switching itself. In this case, it's something known as interlead capacitance. Everything has some minute amount of capacitance in it. Just a small piece of wire, held near another component, will capacitively couple with it. Also, the internal structure of a bipolar transistor is loaded with things that add capacitive effects as well. We're talking about electrons and holes and the so-called "majority carriers" of the current here so we'd best just leave it at that for now.

Normally, these small capacitances have no effect on a circuit at all. They're just too small. But as the operating frequency rises, the time between cycles gets shorter. If the time constant formed by the combination of the resistance of the bipolar transistor and the interlead capacitances of both the transistor itself and the rest of the circuit is too long, the circuit will become inefficient, dissipating vast amounts of waste energy as heat and destroying the bipolar transistor.

MOSFET to the rescue

Enter the MOSFET to the rescue. The MOSFET (Metal Oxide Semiconductor, Field Effect Transistor) looks exactly the same as a regular transistor. It comes in the same TO-220 package that is familiar to everyone. (see figure 1)

But they are a bit different in other respects. The names of the three component leads are different. In the transistor, the three component leads are called the emitter, collector and base. In the FET they are the source, drain and gate.

Although the names are different, their functions are much the same. As discussed earlier, the major current flow through a transistor is between the emitter and the collector. It's called the collector current. In the MOSFET, the same job is handled by the source and the drain. When turned on, the MOSFET closes the source/drain connection, completing the circuit. The main current flow in a MOSFET is called the "drain current."

The remaining component lead is the controlling element of the device. In the transistor, the "base" lead controls the flow of current between the emitter and collector. A small voltage on the base will turn the transistor on. In the MOSFET, the controlling element is called the "gate."

There are a couple of things that make the MOSFET a better choice for high-speed switching than a bipolar transistor. One is that when it's turned on, it is really turned on. There is no voltage drop between the drain and the source to speak of. It is as if there was a short piece of wire between the two.

The switching characteristics Like the bipolar transistor, the switching characteristics of a Power MOSFET are determined largely by the various capacitances inherent in its structure. These are shown in Fig.2. To turn the device on and off the capacitances have to be charged and discharged. The speed at which this can be achieved is dependent on the resistance (which is now almost nonexistant, especially as compared to a bipolar transistor) and the current sinking/sourcing capability of the drive circuit. MOSFETs do not suffer from the same capacitive problems which limit bipolar devices due to the way they're constructed. For most applications therefore the switching times of the Power MOSFET are limited only by the drive circuit (which is practically limitless since very little current is involved here) and can be very fast. Temperature has only a small effect on device capacitances therefore switching times are independent of temperature.

In Fig.3 typical gate-source and drain-source voltages for a MOSFET switching current through a resistive load are shown. The gate source capacitance needs to be charged up to a threshold voltage of about 3 V before the MOSFET begins to turn on. The time constant for this is CGS (RDR +RG) and the time taken is called the turn-on delay time (tD(ON)). As VGS starts to exceed the threshold voltage the MOSFET begins to turn on and VDS begins to fall. CGD now needs to be discharged as well as CGS being charged

so the time constant is increased and the gradient of VGS is reduced. As VDS becomes less than VGS the value of CGD increases sharply since it is depletion dependent. A plateau thus occurs in the VGS characteristic as the drive current goes into the charging of CGD .

Testing a MOSFET

That's an easy one. When you have a bad MOSFET, it will be shorted. I've never seen one that didn't. It will often burn up due to the high voltage and current that's often involved in an SMPS. Technicians, well-known for having a superb sense of humor, laughingly refer to a FET as a "Fire Emitting Transistor." It will typically have a drain to source short but you might easily see a drain to gate short as well. That will send big juice through the driving circuit so don't be suprised if you see some component destruction other than just the MOSFET itself.

Unfortunately, a MOSFET doesn't do that whole juction drop thingy that we find when testing a bipolar transistor. You don't see any of the .7volt readings we usually get when testing semiconductors. Fortunately, the shorts mentioned above are obvious and easy to spot.

There is a way that you can sort of test some MOSFETs. Use your meter set to the diode test setting. If your meter puts out around 3 volts or so, it's enough to turn on most MOSFETs.

Connect the black meter lead to the MOSFET's source. Connect the red meter lead to the gate.

Now move the red meter lead to the drain. You should get a low reading. The MOSFET's gate capacitance has been charged up by the meter and the device is turned on.

With the meter positive still connected to the drain, touch a finger between source and gate. The gate will be discharged through your finger and the meter reading should go high.

MOSFETS are rated by voltage and current, just like regular transistors. The voltage rating you're interested in for substitution purposes is called the Drain to Source Breakdown Voltage BVDSS. The current rating is called the Maximum Continuous Drain Current ID.

Sometimes you can tell the rating of a MOSFET by its part number. A typical part number is 20N10L. The first pair of numbers refers to the current rating. In this case, it's rated at a maximum drain

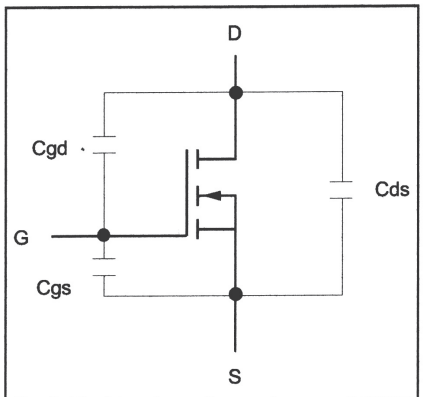


Fig. 2 The internal capacitances of a power MOSFET

current of 20 amps. The N indicates an "N channel" FET. Some FETs are of opposite polarity. These are known as "P channel" FETs. The final 2 digits indicate the voltage rating. The 20N10L is a 100 volt MOSFET. The L suffix indicates that a "logic" level is used on the gate to turn the FET on.

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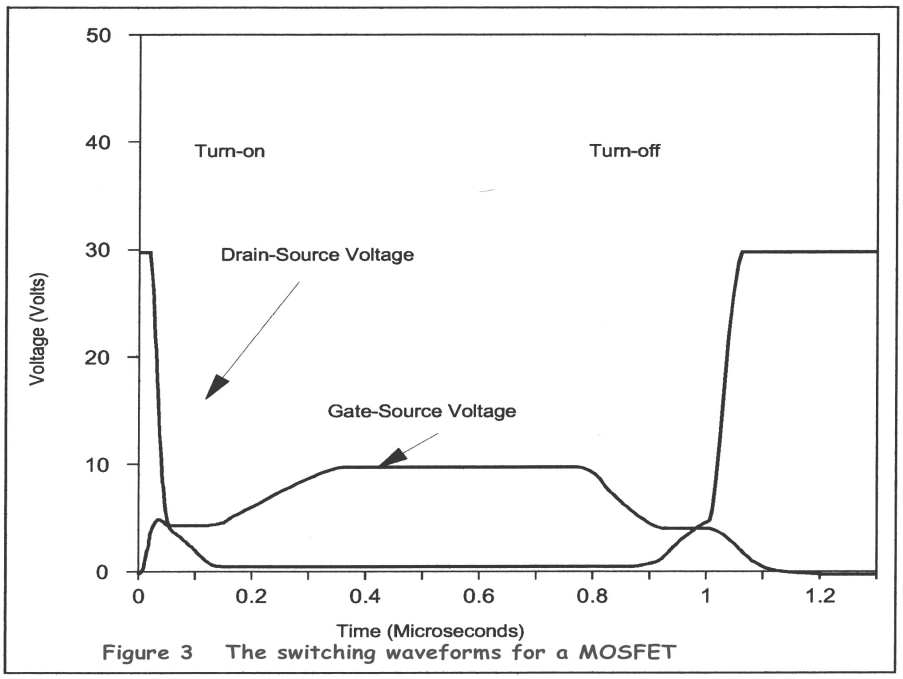

Figure 3 The switching waveforms for a MOSFET

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Hopper Repair - Part II

By Frank Sutter

There are a lot of things to keep in mind when clearing a hopper jam, and last month I began the larger-then-expected task of trying to list them in print. Since this is such an extensive project, lets tie right back into it, shall we?

When the hopper has an escalator, the coin chute will have different characteristics depending on the manufacturer. The problem will be the same, however, because coin chute jams in every type of escalator hopper from any manufacturer will normally widen the entrance to the coin chute. This damage will have to be straightened out in order to prevent the hopper from jamming again. The method of repair, however, will be different because the various manufacturers build their units differently.

In all types of escalator hoppers, the coin chute opening should be no wider then the thickness of one and a half coins of the denomination that the hopper is using. An opening of one and a fourth coin thickness would be better. We'll cover the restoration of the coin chute opening more later, but while we're still on the topic of stubborn jams, let me roll out a few nifty tricks to remove the ones that are REALLY stuck.

I'll begin by saying that in these difficult cases, there is no substitute for good ol' fashioned elbow grease. I'm going to share with you a few tricks that might make the job easier, but in the end, you will probably have to apply a considerable amount of physical strength to get the jam cleared. The hopper motor applies a surprising amount of torque to the pinwheel, and when the coin travel is impeded, and coins begin to shingle up at the jam point, they can really wedge themselves in.

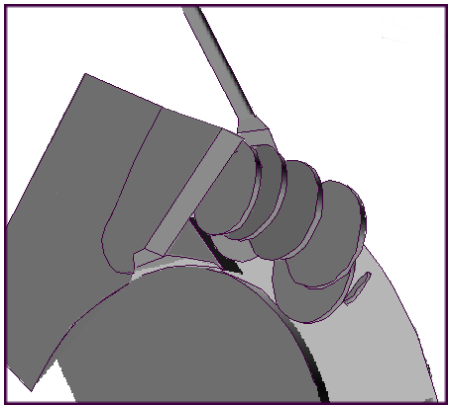


Fig. 1
Levering jam with a screwdriver.

The primary method of freeing a really tight jam is to roll the pinwheel back one spot. Remember that if the hopper uses a brake, you will have to hold it in the disengaged position so that the pinwheel has a chance to turn. Do not rotate the pinwheel back far enough to allow coins to get under the knife from behind, because this could bend the knife. Hopper brakes in general consist of a pawl to stop the driveshaft, and a lever that pushes the pawl to the disengaged position when the hopper motor turns on. This works because the disengaging lever is pulled tight to the body of the motor by the magnetism generated within the motor when it turns on, and current flows through it. Some hoppers, it should be noted, have no brake mechanisms, because they use a DC motor, and these units can stop the coin motion simply by reversing the current flow through the motor. If there is a brake on your jammed hopper, and it is not held in the disengaged position, your force will be applied to the brake mechanism, and not the jam.

If rolling the pinwheel back one place proves to be impossible, the next step would be to pry one of the jammed coins free with a flat-bladed screwdriver. (Fig. 1) In either of these brute force methods of jam clearing, the idea is to match the force that drove the coins into the jam, or better, to lower that force threshold by loosening the screws. Therefore, the next step would be to loosen up all the screws in the area of the jam, and then try to pry the jam free with your screwdriver again.

If the standard screwdriver pry still doesn't do the trick, sometimes the locking needlenose pliers can be used to nip the edge of one of the jammed coins, and yank it out of the jam like a bad tooth. Even though considerable strength will be required with each of these methods, you'll still be able to use only one hand because the other

will be busy holding the brake disengaged. However, you could use two hands if you could hold the brake disengaged in another way. When I felt like I needed two hands. I would sometimes slip a large rubber band over the motor to hold the brake pawl against it's body. In cases where that was impractical, I sometimes temporarily wedged a tool

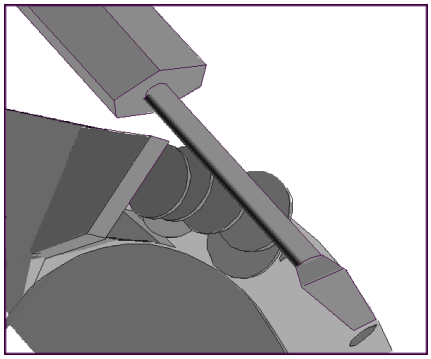


Fig 2.
Rolling pinwheel backwards

between the hopper brake and the hopper base or shielding to accomplish the same thing. Please don't forget to free the brake again when you have finished clearing the jam, or a hopper runaway will result on the first payout that the hopper tries to give. You can write me an email and ask me how I know this is true.

With the brake held in place, it's easy to pull the locking pliers with both hands. You can also use the screwdriver to pry while you pull on the locking pliers. With both hands free, it's also opens up a method to easily apply a matching force to that which wedged the coins in place.

Using a large flat-bladed screwdriver and a light hammer, and with the brake held in the disengaged position, tap the pinwheel against one of it's pins to roll it backward just a bit. (Fig. 2) It's tempting to really whack the screwdriver, because these stubborn jams can be really frustrating, but I find that a controlled rapid series of light taps works much better. When you use this technique, you have to keep in mind that damage to the pinwheel can result from too much enthusiasm, so proceed with caution. Also, be aware that the jammed coin, which is probably bent or damaged, may fall back into the hopper. To allow for quick recovery of these coins, you might consider sticking a small piece of black tape to them before you use this powerful jam clearing technique. Also, be careful not to roll the pinwheel back more then one place, or there is the danger of coins rolling under the knife from behind. If this method of applying enormous reverse force to the jam fails to free it up, I'd be willing to bet that there is another problem that is holding the pinwheel in place.

If none of these techniques have succeeded in freeing one of the jammed coins with the brake held in the disengaged position, you might have to try removing the knife and the coin chute cover. It's not a good thing to have to disassemble the hopper if a customer is waiting, but sometimes this small amount can increase your chances of freeing the jam considerably.

Using any of these methods, or any time you free a coin jam, in fact, remember not to put the coins that you removed back into the hopper. Most often, they were damaged before they became jammed, but even if they weren't, it's very likely that the actions that had to be taken to remove the jam has damaged them. It's better to throw them down the drop.

That about covers the tricks I know to free stubborn jams, so lets get back to that widened coin chute opening that I mentioned above. It's simple physics that two coins can't go into a space only big enough for one. When they try to force themselves in, the space will be changed to the extent that they succeed. The coin chute is an important part of the coin ejection system, because it is the final gatekeeper left to insure that only one coin gets in at a time. If it is bent, as is often the case, and two coins are allowed in, the hopper will jam again.

On an IGT hopper with an escalator, the coin chute cover is part of the escalator assembly. These components are quite sturdy and reliable, but when coins have levered themselves underneath and doubled up, they can bend as well as any other brand. This will leave the leading edge turned up and fluted, and frequently close to two coins wide or even wider. This makes the hopper much more likely to jam again. As a field repair, many technicians like to narrow this opening with a long handled flat bladed screwdriver and a hammer. (Fig. 3) When a customer is waiting, this is probably the best idea, since it's both quick and effective. but I have found that the resulting coin chute opening acquires a chewed

sort of look and a wavy leading edge that just can't be good. It should come as no surprise that when this sort of repair has been done to a coin chute cover enough times, the jam frequency on that hopper will go up dramatically. Sometimes, these components can be rescued, but more frequently, they have to be replaced.

When there is time to do a long lasting repair to the hopper, there are two techniques I used to use to restore these IGT coin chute entries. The first is to remove the coins from the hopper, and to remove the plate mounted across the hopper, allowing free access to the coin chute cover. At that point, it is possible to straighten the coin chute cover directly with a hammer. This technique is remarkably effective for doing a long lasting repair, because it leaves an edge that is far straighter then you might be able to achieve with a screwdriver blade. However, you shouldn't use this technique on the floor because it's a little bit intimidating for the patrons.

If you find yourself in the position of repairing a coin chute entry that has been repeatedly "quick fixed" with the flat-bladed screwdriver, and has acquired that chewed, wavy look, it is probably a good time to restore that leading edge. Now it probably should go without saying, but I feel compelled to mention this anyway. NEVER use this technique on the floor, this is only in cases where complete disassembly is required. This technique is to remove the coin-chute entry piece entirely from the hopper, clamp it gently in a vice, and clean up the damaged leading edge with a hand-held rotary tool. Between this technique and using the hammer and a flat surface to straighten out any bending that has occurred, you should be able to restore a like-new functionality to the workpiece, and actually solve the chronic jamming problems that are commonly caused by this condition. These repair techniques involve true craftsmanship and before you attempt them, you should be very familiar with clearing hopper jams, and have carefully studied what it is that a hopper might need to operate properly.

On some escalator hoppers,

the coin chute entrance is a separate, small, wedge-shaped plate held in place over the coin path by two screws. These pieces sometimes bend when two coins get wedged underneath, but because of the simplicity of the design, they are quite easy to remove and straighten right on the floor. If you feel that the piece will require a bit of tapping with a hammer to straighten it out, feel free, but I found that two pairs of small locking pliers are sufficient to bend the piece back into perfect shape.

That about covers the coin entry chute, so it's time to turn our attention to another chronic problem, the escalator. In my next article, I'll touch on clearing jams that occur in this diabolical piece of engineering, and how to restore these units to a like-new condition after damage has occurred. I also hope to talk a bit about wiper adjustment, the infamous "frozen pinwheel" the free pinwheel, and other hopper topics as well.

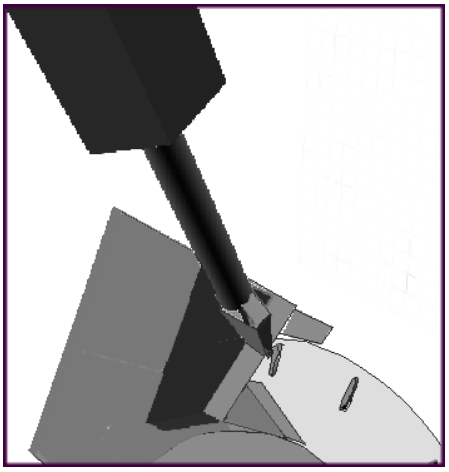


Fig. 3
Straightening bent coin entry chute.

When I started this series, I thought that three articles would cover the fundamental topic of hopper jams, but I can see now that three articles is just enough space to touch lightly on the major topics! Just understand that no amount of my writing and your reading will ever make you an expert on hopper repair. You simply must make a few jammed hoppers pay again to learn it. What I have presented here are simply a set of ideas that a new technician can keep in mind when he or she approaches a jammed hopper. Hopefully, the technician can have confidence that no matter what the problem is, he or she will be able to make it pay again.

Till next time, keep 'em running!

- Frank Sutter
fsutter@slot-techs.com

Jammin' with Chris Hunt

Well fellow Techies" It's that time of the month again and I have managed to rustle a few little gems together for your enlightenment. It seemed that my writings came to haunt me in the past few weeks with me being able to put my experiences to good use. In last month's issue I talked about the 7v fuse blowing on the IGT PE+ machine, well I got that one. It turned out to be one of the "hot" lamp feeds to the buttons that had chafed and shorted to the door causing the 7v to go to ground and blowing the fuse of course! So, watch out for that one.

This month I will cover some sneaky processor board faults for you, so read on.

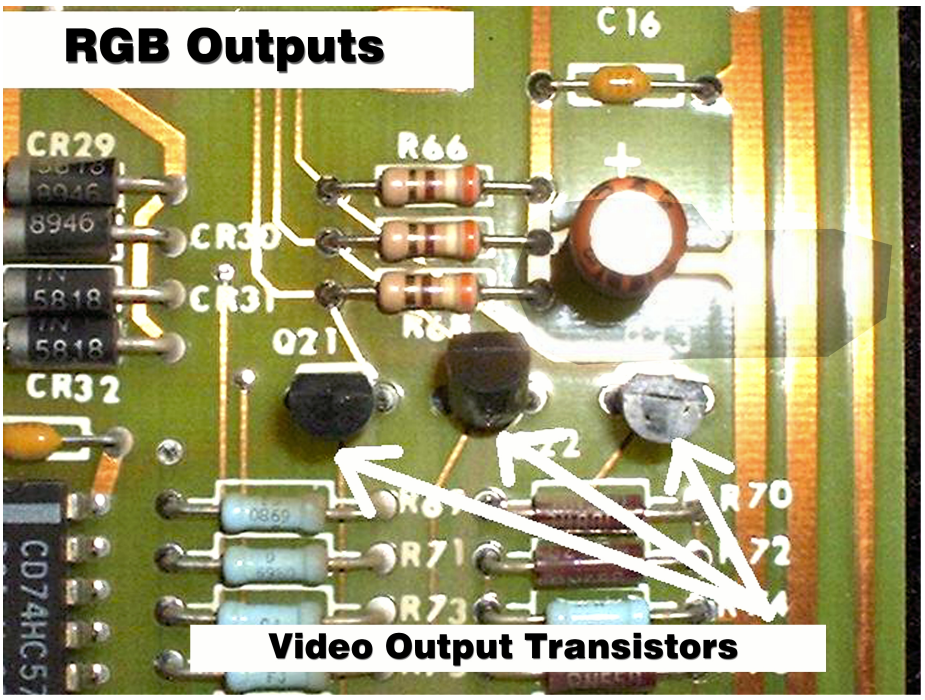
IGT PE+
Constant door open signal

You are called to a PE+ video and the onscreen message is "DOOR OPEN." After checking the obvious (and the 7v fuse) enter the input test. If you are running later software, the door signal should be showing a rapid 01010101 sequence (the encoded security pulse) when you close and latch the door. If the state changes to a solid 1, the probable cause is a transistor on the processor board. Remove the board and locate Q5 (2N3904) check it with a DVM and you'll find its gone collector-emitter short allowing the optic supply to be on all the time. Replace the transistor and you're back in business. It may be worth checking the wiring around the door area that feeds the IR led to make sure that there are no shorts. For those of you who are babysitting the IGT S+ reel slots, look for Q26.

IGT PE+
Missing or overdriven colors on monitor

You notice an IGT PE+ on the floor with funky looking colors on the monitor. After trying a known good Ceronix monitor, it's still the same. The cause will be on the processor board. Remove the board and locate Q21, 22 and 23. Test them with a digital multi-meter (DMM) or other transistor tester to see if they are open or short. If shorted, you will have a dominant color overlay. If open, you'll be missing red green or blue.

They are as follows: Q21=Blue Q22=Green Q23=Red. These generally fail if the monitor frame is not correctly grounded. If a "flashover" occurs, the high voltage tries to find its way to ground via the processor board, committing the homicide of the RGB video output transistors on its way. Look for machine entry cards shoved between the monitor frame and the monitor shelf... Hey, stranger things have happened!



These are the three video output transistors on the IGT PE+ board. When you have color problems that are not related to the monitor itself, this is a good place to look.

IGT PE+
No progressive pulse going to the overhead.

This is a rare one but has been a pain for many slot techs I know. Because you are looking at a peripheral system, you can be misled easily. So you've been through all the obvious stuff: connections to the machine motherboard, pigtail harnessing leading to the progressive controller, etc. You've even dropped a hundred coins in just to make sure that it isn't incrementing.

Remove the processor board and locate CR20 (1N4148 Diode). Using your (or your buddy's) DMM, check to see if it's short circuited. This diode is used as a damper to drain any back pulses (EMF) should the machine be tied to an inductive device such as an electromechanical counter. If it proves to be shorted, check its partner Q18 (2N3904). It also may have failed. This circuit is almost a repeat of the door interrogation layout.

IGT PE+
Bar poker not crediting when fed with bills

Lets take look at a problem I came across a little while ago. It involves our old friend "The Bill Validator" AAAAGH! (You know it) An IGT PE+ refuses to accept any bill. The BV will take the bill, hold it in escrow for about 10-15 seconds and then return it. Check for BV communication in the input test and watch for a change of state when a test bill is inserted. Yes, the BV is communicating with the processor. After you have done your daily "Swaptronics" (see April, 2001 Slot Tech Magazine) by changing the head, transport and stacker can, and if you were really adventurous (or desperate... ha ha) the processor board as well, it's still doing the same #@%&**#@ thing.

Try this... If you have access to a "Set 4" set denom chip, you're home and dry. After recording all relevant meters, use the set denom EPROM and run through the setup as prescribed. Bring back the game and ...TADA! It accepts bills again. If you have any aftermarket retrofit PE+ Drop in Bar machines with the GPT BV system (ex CVB) this problem may be more common.

IGT S+ reel slot
Handle won't release when coin is inserted

You are called from your lunch break to an IGT S+ reel slot. The customer is of a traditional nature and likes to "Pull the handle" but complain that they can't. Of course, they refuse to use the "spin reels" button. After checking connections and wiring, the culprit is most likely Q16 (MAC3030) located on the main processor board. Just for a change, this is a TRIAC and if you read last month's issue you'll know all about those. Once again, get the DMM (by now your buddy is contemplating charging you a daily rental) and check for odd readings, especially across legs 1 and 2 (MT1/MT2). There is an actual output test but I cannot be sure of the group number as it changes with different SPO program chips. The TRIAC is driven by a triac driver IC (a white package next to Q16) but it's highly unlikely that this has failed.

Cheap pot adjusting tool (good for adjusting CC series comparitors)

Finally, I have included a picture of a useful little pot adjustment tool you can make if you're short of a few pennies. Using a large wattage high value resistor (>2W@1megohm) cut off one leg. Flatten the end of the other leg to about 3/32" or 1.5mm (Eurotechs!) with a small hammer on the back end of a bench vise. Put heatshrink over the leg for insulation. Because the leg is copper, it's "soft" on some pots and you won't use a lot of torque. The high value is to prevent being zapped if your finger touches the cutoff leg end. Of course, you can always insulate this end with a larger diameter piece of heatshrink tubing as well.

Well guys (and girls, 'cause you're out there too) keep up the good work, stay busy and most of all KEEP JAMMIN!

-Chris Hunt
chunt@slot-techs.com

PM Schedules and Logs

By Frank Durso

These are the forms that I currently use for my maintenance schedule. The first form is given to each technician at the beginning of every month. Each tech has a different job based upon their ability, work schedule or specific task they have for the given month. Knowing the capabilities of each tech is very important when assigning a task. Each month the tasks change from tech to tech so each duty is tracked on a month-to-month basis. The shaded areas of the sample form indicate that specific tech's work schedule during the month of April.

The second form is where I keep track of what has been done for a 3-month period. Every time a tech completes a bank of tasks, they mark the bank with the date and initial it. I can look at random on a daily basis to determine who is getting the job done and who is slacking. I also do a periodic check of the bank to assure that the work is done correctly and to my standards.

This seems to work well at my casino as long as the maintenance task fits the tech and the shift they have to work (Obviously I can't assign a tech who works a Friday night shift do maintenance on monitors on the floor. It's just too busy.).

Hope this may help someone. It works for me at the moment. If other Slot Tech Magazine readers know of any other way to accomplish this, I really would love to know about it.

-Frank Durso
fdurso@slot-techs.com

Tech name		Job title	Technician	Month	March	Level	
Department		Zone	A,B,C & D	Starting Date	4/1/2001	Term	

WEEK 1				\			4/1
LOCKS							
BUTTONS							
METERS							
LAMPS / LED							
RIBBONS							
SWITCHES							
Power Supplys							
TOUCH SCREENS							
BILL ACCEPTORS							
Hopper							

WEEK 2	4/2	4/3	4/4	4/5	4/6	4/7	4/8
LOCKS							
BUTTONS							
METERS							
LAMPS / LED							
RIBBONS							
SWITCHES							
Power Supplys							
TOUCH SCREENS							
BILL ACCEPTORS							
Hopper							

WEEK 3	4/9	4/10	4/11	4/12	4/13	4/14	4/15
LOCKS							
BUTTONS							
METERS							
LAMPS / LED							
RIBBONS							
Power Supplys							
SWITCHES							
T.SCREENS							
BILL ACCEPTORS							
Hopper							

WEEK 4	4/16	4/17	4/18	4/19	4/20	4/21	4/22
LOCKS							
BUTTONS							
METERS							
LAMPS / LED							
RIBBONS							
Power Supplys							
SWITCHES							
T.SCREENS							
BILL ACCEPTORS							
Hopper							

Special Instructions

Bill Acceptors--- Inspect & repair all Bill Validator wiring & connectors

WEEK 5	4/23	4/24	4/25	4/26	4/27	4/28	4/29
LOCKS							
BUTTONS							
METERS							
LAMPS/LED							
RIBBONS							
Power Supply							
SWITCHES							
T.SCREENS							
BILL ACCEPTORS							
Hopper							

SECOND QUARTER (2001) BANK MAINT. LOG

Bank		Locks	Buttons	Meters	Lamps / LED	Ribbons	Switches	Touch Screen	Bill Acceptors	Hopper
	Date									
23	Tech									
	Date									
24	Tech									
	Date									
25	Tech									
	Date									
26	Tech									
	Date									
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41	Tech									
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	Date									
	Tech									

Unlock the Mystery of Monitor Troubleshooting

B+ is the Key

Of all the tests and measurements you can possibly name, none is more important to the art of monitor repair than measuring the B+ power supply.

If you have a monitor with a blank screen, your problem might be in the B+ power supply. If your monitor takes a long time to come on and has a dim picture, you may have a bad B+ power supply. If your monitor has a picture that's doing the hula, you almost certainly have a bad power supply. If your monitor comes on for just a fraction of a second and shuts itself down, you probably have (you guessed it) a B+ power supply problem.

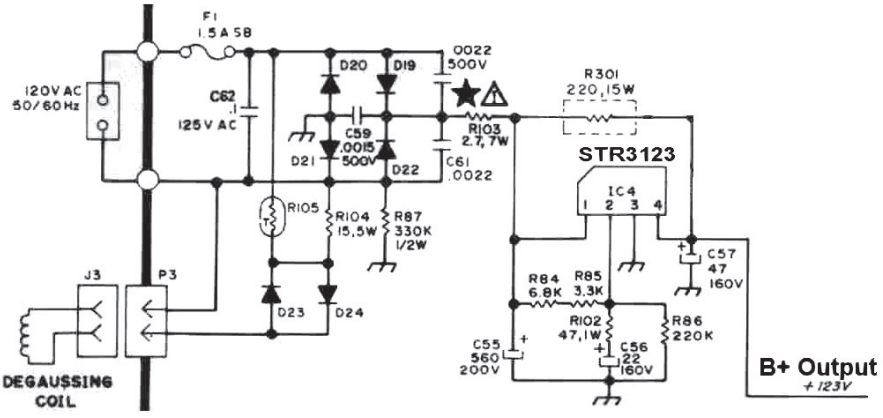
Most monitors, regardless of manufacturer, have one main power supply of between +88 to +136 volts DC. This is the power supply that directly provides the operating current for the high-current circuits in the monitor. Specifically, this power supply, known as the B+, provides the operating current for the two deflection circuits and the high voltage unit. These are the highest current circuits in the monitor, accounting for more than 80% of all the power consumed by the monitor. REMEMBER THIS FACT, as it will explain a lot about monitor troubleshooting, as you'll read later.

The term "B+" is actually a throwback to the old radio days when all radios were battery-operated, vacuum tube sets. They required three types of batteries for operation. A low voltage "A" battery provided power for the tube heater filaments, a high voltage "B" battery provided positive voltage for the vacuum tube's "plate" supply while a moderately rated "C" battery provided a negative voltage for the vacuum tube's "bias" supply. When power supplies replaced batteries, we held on to the term "B+" as an indicator that this is the main power supply for the set (radio or television.)

What's Normal?

One of the keys to successful troubleshooting is to know what's normal. The best way to learn this is to measure the B+ voltage every time you work on a monitor. This may seem like a waste of time when you have a problem like a missing color or vertical collapse (which couldn't possibly be caused by B+ problems) but it serves to reinforce both the methods of obtaining the measurement and the meaning of what is a normal voltage for the B+.

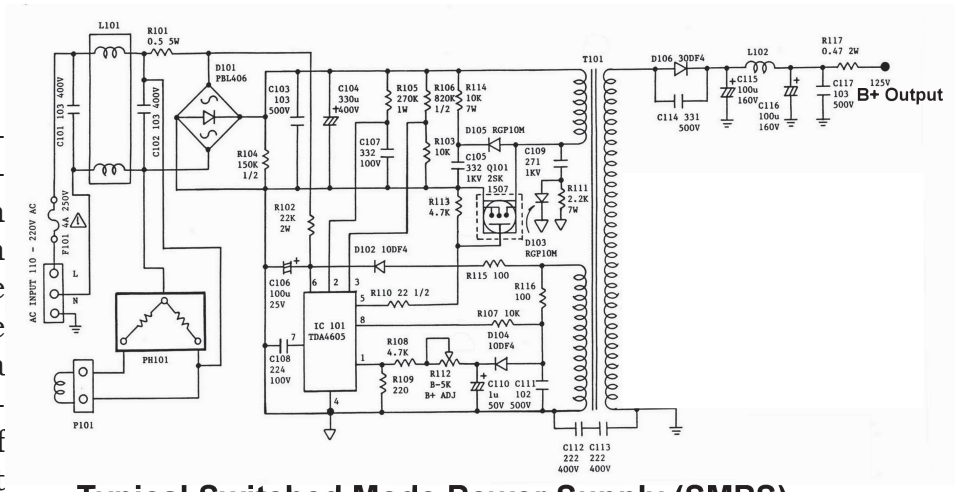
As mentioned earlier, normal B+ voltages are typically between +88 to +136 volts DC. This will vary between manufacturers and models. Also, there are two types of power supplies we now see in monitors. The majority of monitors now on site use a "linear" or "conventional" power supply. Modern designed monitors use a "switched mode" power supply or "SMPS." You can easily recognize a monitor with an SMPS by the yellow, ferrite-core power transformer mounted on the PC board. Monitors with linear power supplies typically are transformerless, "hot-chassis" types.



Typical Linear Power Supply
Using an Integrated Circuit Voltage Regulator

Where to Measure the B+

A schematic diagram is awfully important when working on monitors. Although there are similarities between monitor designs, no two are exactly the same. Having the schematic diagram helps a lot because the B+ is generally labeled at the output of the power supply. Even if it doesn't say "B+" it will generally be labeled with the voltage.



Typical Switched Mode Power Supply (SMPS)

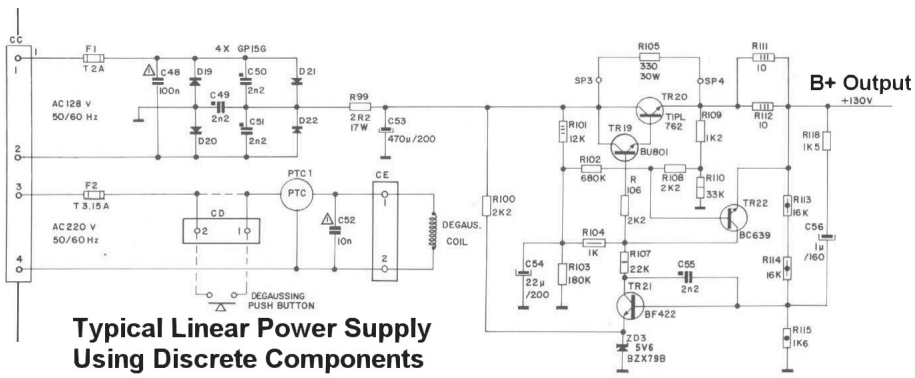
If you don't have a schematic, here's how to locate and measure the B+ in just about anything:

SMPS - Find the yellow power transformer. The output windings (the secondary windings) will be connected to diodes and electrolytic capacitors. Just follow the traces on the bottom of the printed circuit board. These are the output rectifiers and filter capacitors of the power supply. In most monitors, the value of the filter capacitor will be around 200 microfarads at 160 VDC. This may vary somewhat. The voltage across this capacitor is the B+ voltage you want to measure.

But it is inconvenient (not to mention potentially dangerous) to measure the voltage here on the bottom of the PCB, with the board propped up and the power turned on. Instead, with the power turned off, follow the trace from the positive lead of the output filter capacitor as it makes its way across the bottom of the PCB connecting all of the components and circuits that require B+ power. Find a component lead connected directly to this B+ trace, where it will be convenient to measure the B+ FROM THE TOP of the PCB. Now flip the chassis back over into its normal operating position and apply power. Connect your digital multimeter's black lead to the chassis of the monitor and the red meter lead to the convenient test point you just ascertained. Use your DMM to measure the DC volts. That's your B+ voltage.

Linear Power Supply - Not quite as standard as the SMPS, there are a couple of ways to locate the B+ test point in a monitor with a linear power supply.

The quick way is to look for a large, ceramic, wire-wound resistor with a value of 150 to 330 ohms at 15 to 25 watts. It will often be mounted on the side of the chassis, affixed by a mounting bracket to the heatsink.



Typical Linear Power Supply Using Discrete Components

This is a "shunt" resistor that helps carry some of the current so the voltage regulator doesn't have to work so hard, lowering the voltage regulator's operating temperature. This is an excellent place to check the B+ power supply. One side of the resistor is connected to the input of the voltage regulator; the

other is connected to the output of the B+ voltage regulator. Simply connect your black meter lead to the chassis and with the power applied to the monitor, use the red meter lead to probe first one side of the resistor, then the other. The side with the least voltage on it is the B+ output.

If there is no shunt resistor, look for the voltage regulator itself. If this is an IC voltage regulator, it will often carry a part number like "STR3123" or "STR30130." The last three digits indicate the output voltage of the regulator; thus you would expect to measure +130 volts at the output pin of the device. If you do not have a schematic that indicates which pin is the output pin, simply check them all. With the power turned on and the black meter lead connected to the monitor chassis, carefully probe each pin of the regulator. One will be B+ output. KNOWING WHAT'S NORMAL, only one pin makes sense as the output pin.

WARNING: There is an EXTREME danger of slipping with your meter probe when making this measurement. If you aren't 100% certain you can make this "power-on" measurement without slipping and letting the smoke out of a bunch of components, it's better to connect your meter probe with the power turned off using a clip lead then apply power and take the reading off the meter.

Another, "power-off" way to locate the output pin of the voltage regulator IC is to set your meter to the continuity beeper or lowest resistance scale, connect one meter lead (either one) to the collector of the horizontal output transistor and probe each pin of the voltage regulator with the other meter lead. The meter will beep or show an ohm or two when you hit the output pin. Of course, this only locates the output pin of the voltage regulator. In order to measure the B+, you must connect your meter, apply power and make the measurement.

If you're working on an older monitor that uses discrete components (individual transistors, diodes and resistors) instead of an integrated circuit voltage regulator, the trick with the big shunt resistor often applies as well. If you do not see the shunt resistor, the B+ can usually be found at the emitter of the series-pass regulator transistor. This transistor will always be the largest one in the regulator circuit. Typically it's in a TO-3 package.

In Next month's Slot Tech Magazine: Associating B+ readings with specific monitor failures . . . How to pinpoint your troubleshooting based on B+ measurements.

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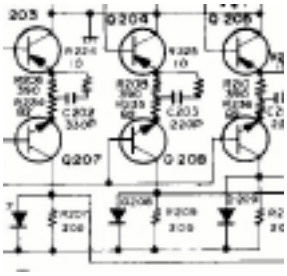
ELECTRONIC COMPONENTS

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.

MONITOR REPAIR

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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Who Are the Best Slot Techs?

By Mike Thomas

How good are you? Are you the best? Do you have what it takes to be the best? Are you on the right path to success? Odds are if your reading this article, furthermore this magazine, you're interested in the answers to these questions. I often found myself wondering, "What do other techs do? What are they capable of?"

I take pride in my work and anyone who does, needs a reference; something to judge himself against. Let's face it, what makes you a quality tech in your casino might make you a "super tech" in another but a junior tech in the next. I have had the opportunity to meet a lot of techs in the last couple of years. Some have made me feel like a slot god while others have made me feel like a slot goof.

To get started, you have to define what a slot-tech is. You have to consider the dynamics of being a slot-tech and determine the common denominators among them. It's not just about being able to fix anything and everything. That helps but there are many more factors that are often overlooked.

My definition of a slot-tech is as follows: slot-techs minimize down time of all slot machines, execute slot moves in an efficient manner and monitor proper operation and conduct repairs on associated player tracking equipment.

I think the simplicity of this definition most appropriately states what is expected of today's slot-tech. Some of you may think this definition leaves out some very important points such as preventative maintenance, component level troubleshooting, and repair of card shufflers, coin sorters or jet sorts etc. The fact is that most casinos don't ever do any preventative maintenance. However important it may seem, most casino directors don't believe the importance justifies the extra cost in staffing to be able to conduct a full scale preventative maintenance program.

Next, I don't mention component level troubleshooting because if you're at that level, you would typically be termed a bench tech, not a slot-tech, therefore factors like machine moves don't even apply to you. The modern slot tech is not afforded the time, resources or training to perform a lot of in depth component level repair. "Quick" component level fixes are a must though, like knowing which diodes or which capacitors typically fail to cause your monitor's picture to shrink or your comparitor to accept anything for credit. It's great when you work at a casino which affords you the opportunity to work on card shufflers, jet-sorts, and signage but these aren't the most important. It's all about the slots. Hopefully by now your asking "Upon what merits should I judge myself ?"

How do you fix a slot machine? Do you use a logical approach or just stab around hoping to find a cure? I'm talking about Diagnostics of course. The single greatest tool slot techs can possess is their ability to use machine diagnostics. I like to think of the machine's diagnostics as getting the machines opinion of how it's operating.

Here's a good and simple example: When you approach an IGT S-plus machine that's not accepting coins, what do you do? Do you open the door, change the coin, blow out the comparitor, close the door and try to feed it a coin? Or, do you open the door perform a quick visual inspection, then immediately go to output test 34 to see if the comparitor's getting power and to test it with the door open. Luckily, due to the proliferation of video machines, IGT vision games and more sophisticated front displays on your newer, sigma type real games, it has become easier and easier to use diagnostics. The days of carrying diagnostic reference cards for each game type on the floor are luckily coming to an end. All the more reason to familiarize yourself with built in machine diagnostics. When you approach a machine and you're not sure what the problem or the cure may be, go to the diagnostics. Every good tech knows that this is the first step to success.

Bill Validators are the next area that every great tech needs to be familiar with. Do you know how to calibrate JCM DBV 200 or WBA heads? Yeah that's an easy one. What about a DBV 145 head where you must utilize your ability to use an oscilloscope and a Digital Volt Meter? You should also be familiar with repair and calibration on some of the other major bill validators such as Mars and GPT. Most technical managers look for techs who are skilled at bill validator maintenance because this is a very high profile job in most casinos. This is the source of a lot of complaints by customers and often everyone in the slot management team monitor the operational status of the bill validators. With the low denomination, high line bet trend in the industry, bill validator maintenance has become more and more important. Unfortunately it isn't appealing to a slot player to insert ninety nickels in a slot machine, unless of course they're only at your casino to get as many free drinks as possible from the cocktail waitress.

Speed Through Good Judgment

Yeah, you can fix a serious hopper jam in a Williams slant top but how long does it take you?

This is what fellow Slot Tech Magazine writer Bart Holden says about being a great slot tech: "I try each time to clear that hopper jam faster than the last. I try to shave seconds off the time it takes me to set up the daily slot tournament..."

Being a slot tech means not only taking pride in the complicated repairs but the simple day-to-day ones as well. I once worked with a slot tech that could fix anything but no matter what the repair was, it

took him an incredibly long time for each one. If you have an excellent tech who fixed five of the toughest repairs in one night and a less experienced tech who fixed 15 which had simple problems, who's more valuable to you?

Slot machines are worth nothing to a casino when they're down. Sure, you and your co-workers can keep the machines running on a Friday night but what if your co-workers called in sick? Would you be able to support the floor successfully on your own? To do this, a slot tech must exercise good judgment and efficient repair procedures. This tech must be able to forego a more interesting, time consuming repair on a busy Saturday night in order to pay attention to the hopper jams, BV jams and faulty comparitors if it's in the best interest of overall floor operation.

Slot Moves

At this point I find it necessary to talk about a slot procedure most of us would rather not think about nor talk about. A lot of techs I know would refer to the following phrase as cursing, that is "Slot moves." From the slot directors' and managers' point of view, this isn't a big issue. To them, it's merely numbers and letters moving around on a page. The slot moves are just experiments to them on attempts to improve numbers and percentages. To a slot tech, it's a whole different beast. After all, slot techs don't spend their time snugly lining up bases, carefully placing the machines in perfect rows, skillfully wiring up auxiliary and drop compartment switches to look clean and reduce the chance of accidental disconnection just to rip these same machines from their homes and move them to the other side of the casino two months later, but we do.

We can't change this so the great tech embraces it. He envisions the slot moves and focuses on the most logical approach. A great tech is in the type of physical condition to withstand dropping and lifting thirty machines in his shift if he's required to. The physical demands on a slot tech are getting greater; the machines aren't getting any lighter. The video monitors are making them heavier, the manufacturers are making them taller and wider, adding wheels, extra

Cont - Pg. 28

TAKING BILL VALIDATOR REPAIR TO THE FLOOR

By Bart Holden

Bill validator (BV) failure can account for a substantial loss of revenue on the casino floor. On a daily basis, I see potential customers approach a game, try to insert a bill, and walk away shaking their head when the validator fails. While there are many types of validators in the industry, I will be focusing on Japan Cash Machines' (JCM) World Bill Acceptors (WBA) and Dollar Bill Validators (DBV). However, much of what will be discussed applies to other BVs as well. This is a guide to successfully decreasing the amount of down BVs on your floor.

REQUIRED TOOLS AND PARTS

You should get a tool cart or some sort of cart to transport your tools. You will need to grab some spare hardware (latch pegs and guide pegs) for your cashboxes. You can grab some Loctite, a rivet gun, and a few handfuls of 1/8-inch buttonhead rivets for a tip I'll share with you later. Take a few spare BV heads, power supplies, and transports to swap out any faulty parts on the floor. If you have a problem with slot machine doors getting slammed on you harnesses, grab some spares. If you are allowed to do so, make a test cashbox for each type of validator to bring along and some sticky labels to tag bad cashboxes so they can be repaired after the next drop. Sign out some cash to test the validators and we're ready to get on the casino floor.

GETTING STARTED

Once you determine a validator is not accepting bills, you will need to ask yourself a few questions. Is the head taking the bill in and rejecting it? Or is it not pulling the bill in? If it is rejecting the bill, try to clean the sensors and rollers. If it will not take the bill you will need to check your power supply and inspect your head, transport, and cashbox.

CLEANING

Clean the sensors with a soft, lint free cloth and a mixture of water and mild detergent such as dishwashing liquid. **Never use an organic solvent such as alcohol or thinner to clean the head.** When cleaning a WBA, be sure to clean the nine rollers located in the head. These rollers accumulate a residue that is made up of skin, coin dust, sweat and a few other non-identifiable products. The flathead end of a vendor screwdriver works wonders to remove this build up. Always allow the head to dry for a few seconds prior to closing.

ON FLOOR CALIBRATION

If you are working on a WBA, you can calibrate the head at the game. Remember **always** clean the sensors prior to calibration to achieve the optimal calibration. To calibrate, remove the entire BV assembly from the machine and set dip switches 1-2-3-4 off and 5-6-7-8 to on. The dip switch pack is located on the transport just below the BV head. Replace the assembly in the game and wait for the BV to ready up. Insert the WBA calibration paper, part number 057619 into the head just as you would feed a bill. It will automatically move in and out of the head

until it eventually stops and the process is complete. Determine if the calibration was complete by looking at the BV ready up light on the front of the game. The light should blink continuously at intervals of 1/10-second. If the light blinks one to eleven times at 1/2-second intervals, the game did not calibrate successfully. You should remove the BV head and transport to the shop for troubleshooting in accordance with the service manual. Return your dip switches to the normal settings and try a bill. If it still rejects you may have a problem with the transport or one of your harnesses and should swap accordingly with your spares until you can rebuild the bad parts back in the shop.

CHECKING POWER

If your game will not take in the bill, first disconnect and reconnect your power harness. This will cycle the entire BV assembly and may fix the problem. Once you work on BVs and become accustomed to them, you can listen or feel when a BV is cycling properly. If you still don't hear the BV cycle, remove the head and transport and see if you have a bill jammed in either the head or transport. Remove any jammed bills and return the assembly to the slot machine. If the BV is still not cycling, make certain that your power supply harness is connected. If it is connected try to replace the power supply with a spare one. If this doesn't fix the problem, make a note that the game needs some serious troubleshooting and move on. There's no sense spending hours on one validator when you could repair at least ten in that time. If you hear a grinding noise when you first cycle a BV, check your cashbox.

Cashbox Troubleshooting

Most of the time a grinding sound simply means that the drop team didn't seat the cashbox properly. Remove the cashbox and check for any loose or missing hardware. If your latch peg is missing and the threads are stripped on the cashbox, you can rivet the latch peg spacer to the cashbox using your rivet gun and one of the 1/8 inch rivets you brought along. If you have constant problem with your hardware coming out apply a small amount of Loctite to your screws and tighten. This is a sure remedy and will eventually minimize the replacing of cashbox hardware from your daily routine. Next, reinstall the cashbox and listen to see if this made a difference. If there is still a grinding sound, you may have an internal cashbox jam or a faulty cashbox. Occasionally you can free the jam with a long screwdriver. If all else fails, try your test cashbox and label the bad cashbox if this fixes the problem.

OTHER "GOOD TO KNOW" INFORMATION

If you have a bill acceptor that cycles correctly but will not ready up when the door is closed, you can check the power supply. You may have a cracked or cold solder joint on the capacitor designated C13. A cold solder joint is simply a dull solder joint that may be loose around the component leg. This is a very common condition on the power supply and is easily corrected by desoldering the capacitor, cleaning the board, and applying a proper solder joint. This bad solder joint on C13 can also cause a game to accumulate double credits when a bill is accepted. Therefore, it is a good idea to check your power supplies from time to time.

Implementing a strong BV repair routine can make a serious impact on your casino's drop revenue and increase the enjoyment of your customer's visit. Keep in mind that this floor maintenance is only successful when coupled with strong bench repair and calibration. Oh yeah, one last thing, it's probably a good idea to let a few different people share the task of BV repair. It has been proven that prolonged periods of BV repair can cause insanity and sudden fits of rage often associated with violence.

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Bill Validators and Preventative Maintenance

By Jeffrey Paunicka

Sticking to a preventative maintenance schedule will enhance the performance of your bill validators.

More than 80 percent of all the dollar bill readers that fail to work can be attributed to dirty read heads, belts, and rollers. Contaminants, such as dust, dirt, and grime, damage these parts. A majority of dollar bill reader down time is due to dollar bill slippage, which is caused by contamination build-up on the belts and rollers. This causes currency slippage, which causes an incorrect read-speed ratio that leads to currency rejection. It seems like there is no way to get around this, because contaminants from dollar bills are deposited throughout the reader during the normal use of the equipment.

Environmental conditions, such as airborne tobacco smoke or oil from food preparation, can also carry contaminants into the reader. There is, however, a simple solution. Establishing a regularly scheduled preventative maintenance program will keep your equipment up and running!

A successful preventative maintenance program includes cleaning your bill validators on a regular basis, as well as following the manufacturer's recommended service schedule. Neglecting to clean your bill validators will cost you. Currency rejection, frequent service calls, and premature equipment replacement that put your machines out of business means lost revenue and customer dissatisfaction. Who can afford that?

What kind of cleaning products should you use? First, you should use a product specifically designed for your equipment. Cleaning should also be convenient for operators and repeated frequently, for example, when you service your machines. The most widely used product approved by gaming manufacturers to clean bill validators is a specially designed cleaning card presaturated in an approved mild detergent solution (AMDS). The cleaning card is simply run through a bill validator like regular currency, and it is very effective in cleaning the read heads, belts, and rollers.

Using AMDS based cleaning cards increases the acceptability ratio in bill validators, which can mean less idle slot machine time or more revenue from ITVMs (Instant Ticket Vending Machines).

Belts and rollers wear out over time with normal use and still need to be replaced periodically. Over time belts may become smooth and/or glazed, and they will become ineffective. Other factors, such as being exposed to the elements can also shorten the belt life.

Cautions!

Alcohol remains the best solution for cleaning bill validators in general. However, several bill validator manufactures in the gaming industry utilize materials for their optical sensors that are sensitive to any contact with alcohol. Only use alcohol bill validator cleaning cards after verifying their acceptability.

Oil-based solvents?

Most manufacturers of bill validators do not recommend lubricating belts and rollers to keep dollar bill validators clean! In fact, lubricated belts and rollers attract contaminants like dirt, dust, and grime more easily—like a magnet. Therefore, lubricating your equipment makes the belt slip, which causes the reader to reject currency. The rejection is due to the resulting incorrect read speed ratio.

Bad Trade-off!

Although lubricants may extend the life of belts and rollers, the decrease in the bill validator's acceptability ratio is not worth it—and increased player frustrations.

Dollar bill reader manufacturers strongly oppose the use of oil-based solvents and/or aggressive aromatic solvents because these solvents attack rubber and plastic parts, which will cause premature failure.

So remember, using AMDS based cleaning cards does not replace scheduled service checkups, but they will prevent unnecessary downtime and service calls. The name of the game is to make money, and sticking to a preventative maintenance program based on cleaning cards presaturated with an AMDS is a safe and effective way to maintain your equipment and revenue flow.

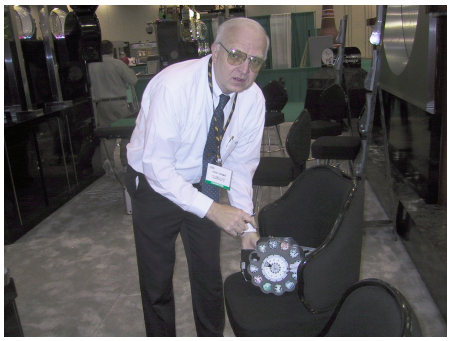
Jeffrey Paunicka is the President of INSIGHT3, South Bend Indiana USA. He holds a degree in Chemistry from John Carroll University and a Masters in Business Administration from the University of Notre Dame. The company can be reached at (800)949-0361

Southern Gaming Summit

Talk about making a silk purse from a sow's ear! Anchor Gaming's SeaQuest is such a pretty game, I just had to photograph it. Add another touchscreen to the mix. - rf

Slot Tech Magazine publisher Randy Fromm with former Viejas chairman and fellow San Diegan Anthony Pico.

AC Coin's field service technician Kevin Smith paused during setup to chat with Slot Tech Magazine about service issues.



R&D engineer Doug Cramer was on hand to discuss the joys and wonders of the new, brilliant white LEDs used in AC Coin's SLOTTO machines. Doug bent over backwards - er, forwards to explain how some of their new sub-assemblies work.

Slot Techs in Mississippi will recognize this dude. I didn't. It's Ronnie Musgrove, the governor of Mississippi giving the keynote speach at the Southern Gaming Summit. Of course, there was little of interest to slot techs here. I just never photographed a governer before. -rf

Formerly of Bally Gaming, Doc Jennings is now Service Trainer at Aristocrat Technologies, Inc. I first met Doc last June during a training mission for the United States Air Force Agency Services at Rhine-main Air Base in Frankfurt, Germany. He taught me a thing or two about hopper control. - rf

The TechFest is Coming . . .

How much can you learn in 3 days?

Introduction to ROMs

By Dennis Gambuzza

ROMs are used to store data and information that doesn't change during the normal operation of the game or system. One example is the game program itself. Another example is the ROMs that contain the image data for a video slot. All ROMs are NON-VOLATILE. That is to say, this data is not lost when power is turned off or if there is a temporary loss of power.

During normal operation, no new data can be written to ROM, but the data can be read from this semiconductor. Some ROMs can't have their data changed once programmed while others can be reprogrammed as often as needed.

ROM Block Diagram

A typical block diagram for a ROM is shown in figure 1. It has three sets of signals: address inputs, control input(s) and data outputs. This example is what is known as a 16 X 8 ROM. This tells us is the ROM's capacity, or how many bits can be stored. To illustrate, suppose that we have a memory that can store 4096 20-bit words. This is a total capacity of 81,920 bits. We could also express this as 4096 X 20. When expressed this way, the first number (4096) is the number of words in memory. It is often a multiple of 1024. It is common to use the designation "1K" to represent 1024 = 2 to the tenth when referring to memory capacity. Thus, a memory that has a storage capacity of 4K X 20 is actually a 4096 X 20 memory. The development of larger memories has brought about the designation "1M" or "1 meg to represent 2 to the twentieth = 1,048,576. Therefore a memory that has a capacity of 2M X 8 is actually one with a capacity of 2,097,152 x 8. The designation " giga " refers to 2 to the thirtieth = 1,073,741,824.

The "Read" Operation

Let's assume that the ROM has been programmed with the data shown in figure 2. Sixteen different data words are stored at 16 different address locations. For example, the data word stored at location 0011 is 1010111.

In order to read a data word from ROM, we need two things: a) apply the appropriate address inputs and b) activate the control inputs. Example: if we want to read the data stored at location 0111 of the ROM we must apply A3A2A1A0 = 0111 to the address inputs and then apply a LOW to /CS.

The address inputs will be decoded inside the ROM to select the correct data word, 11101101 that will appear at outputs D7 to D0. If /CS is kept HIGH, the ROM outputs will be disabled and will be in the Hi-Z state.

Programmable ROMs (PROMS)

This device can only be programmed one time (the CAP chip on an IGT game) so it is commonly called a one-shot. If you want to reprogram, you need to remove the PROM and program another.

Erasable Programmable ROM (EPROM)

An EPROM can be programmed by the user. It also can be erased and reprogrammed as often as desired. Once programmed, the EPROM is a non-volatile memory that will hold its stored data indefinitely. A programming device is needed to program or copy a program to this device.

Please adhere to all gaming laws and patent laws for your area. If there is a "Do not copy" sticker on the label, it will be a violation of patent law to copy this EPROM. DON'T DO IT or get permission in writing from the manufacture.

Ultraviolet light exposed to the window of the EPROM will erase the stored information. The label on the EPROM tells you what is in the EPROM and protects the device from accidental corruption of the data. These devices are sensitive to static electricity so care should be taken when handling them. You

0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	DE
1	0	0	0	1	0	0	1	1	1	0	1	0	1	1	3A
2	0	0	1	0	1	0	0	0	0	1	0	1	2	2	85
3	0	0	1	1	1	0	1	0	1	1	1	1	3	3	AF
4	0	1	0	0	0	0	0	1	1	0	0	1	4	4	19
5	0	1	0	1	0	1	1	1	1	0	1	1	5	5	7B
6	0	1	1	0	0	0	0	0	0	0	0	0	6	6	00
7	0	1	1	1	1	1	1	0	1	1	0	1	7	7	ED
8	1	0	0	0	0	0	1	1	1	1	0	0	8	8	3C
9	1	0	0	1	1	1	1	1	1	1	1	1	9	9	FF
10	1	0	1	0	1	0	1	1	1	0	0	0	10	A	B8
11	1	0	1	1	1	1	0	0	0	1	1	1	11	B	C7
12	1	1	0	0	0	0	1	0	0	1	1	1	12	C	27
13	1	1	0	1	0	1	1	0	1	0	1	0	13	D	6A
14	1	1	1	0	1	1	0	1	0	0	1	0	14	E	D2
15	1	1	1	1	0	1	0	1	1	0	1	1	15	F	5B

Figure 2

can place them on anti-static foam, conductive foam that effectively shorts together all legs of the EPROM. Briefly when you program a ROM device what you are doing is applying a voltage to each word location for a given period of time.

Most EPROM's have other inputs such as CS = chip select and R/W (read/write). Some inputs and outputs are connected to many other integrated circuits on something known as a bus.

Address Bus - This is a one directional bus that carries the binary address outputs from the CPU to the memory ICS to select one memory location.

Data Bus - This is a bi-directional bus that carries data between the CPU and the memory ICs.

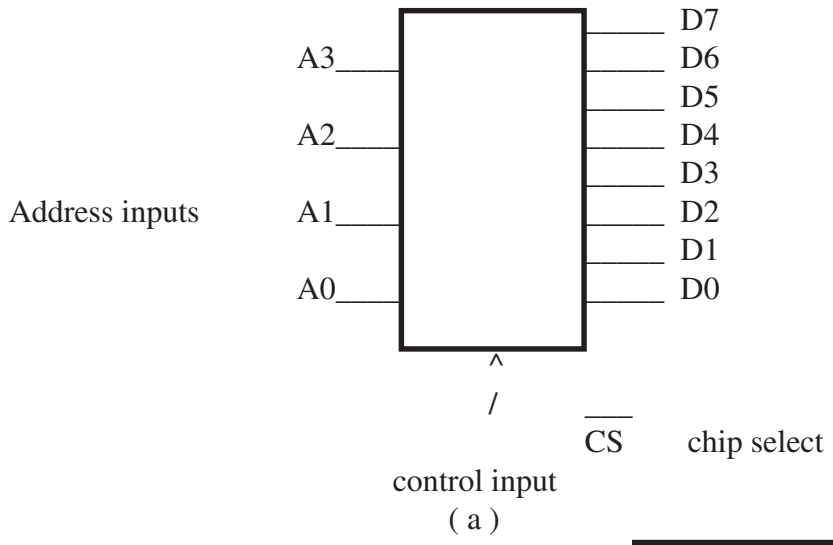
Control Bus - This unidirectional bus carries control signals such as CS chip select from the CPU to the memory ICs.

Electrically Erasable PROM (EEPROM)

This device is commonly found on the IGT PE+ and S+ motherboards. The EEPROM retains the same floating-gate structure as the EPROM, but with a very thin oxide region above the drain of the MOSFET memory cell. This produces the EPROM's major characteristic electrical erasability. One of the advantages of the EEPROM is it can be programmed and erased in circuit. All of us I'm sure have used a Clear and Set chip for the IGT Plus series machines. This is where the denomination is stored in these games. That is why once you DENOM. one game you can put other CPU boards in that machine and only have to press the service switch to bring the game up.

RAM clear - Not!

We all have heard the term, Clear Ram or Zero Ram. Sometimes this is correct, but more times than not this is not accurate. Let's take IGT games, you have a CLEAR chip. This chip sets the RAM at a known number and sets the EEPROM on the Mother Board. So we aren't zeroing, we are setting them to a preset number or word that will start the ROM at the beginning of the program. Yes, the meters are reset to zeros but this is part of the start cycle.



(a) Typical ROM Block Symbol

That's all the time I have for now, but we will be going into more detail and talk about other devices that are used in the gaming industry. I would like to thank Community College of Southern Nevada for some of the text used in this article.

Remember Keep those machines up.

-Dennis Gambuzza
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THE TECHFEST IS COMING . . .

displays and more extravagant bonus rounds requiring more and more parts. A great tech takes pride in the efficiency of the slot move and his ability to lead the move.

I left my thoughts on player tracking for last. The reason is that some of the best techs I know are reluctant to focus on this area with as much attention as it requires. Player tracking systems are becoming very user friendly and great tools for bill validator maintenance and many other repair issues. In the future, slot techs will utilize the resources in these systems more and more to increase the efficiency with which they perform their jobs. A great tech uses this tool to it's full potential. This tech knows that with this system, you can find BVs not accepting or with poor acceptance. Inoperative card readers and door switches are just a few more. For example, on the Bally SDS system you write basic programs to tailor your reports and display the specific data you need. I see a lot of great older technicians allowing the younger ones to outshine them in this area due to their intimidation with the computer systems.

I offer the above notes for many of you to consider when evaluating your own performance. I certainly could have mentioned other variables such as customer service skills but let's face it, everyone in a casino should excel at that. Component level repair techs are great and if your casino offers you the opportunity to develop your skills in this area then you are very lucky.

I wish all casinos would consider hiring and training techs to repair power supplies, monitors, and all the other associated electronics. I believe the ability to save money with in house repair to all these electronic components is strongly underestimated by many in casino management.

That doesn't mean you can't search for opportunities in your spare time increase your education. The great tech remembers that all the skills he acquires at the casino, whether on the clock or not, are his to keep and take with him. Slot techs are very fortunate to work in such a great atmosphere while performing jobs where you learn something new almost every day that will not only make you a great tech at a casino but translate to many other industries as well. A slot tech is fortunate that their job is by far the most costly to train of any job in the casino, while at the same time a tech acquires the greatest amount of skills as well.

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