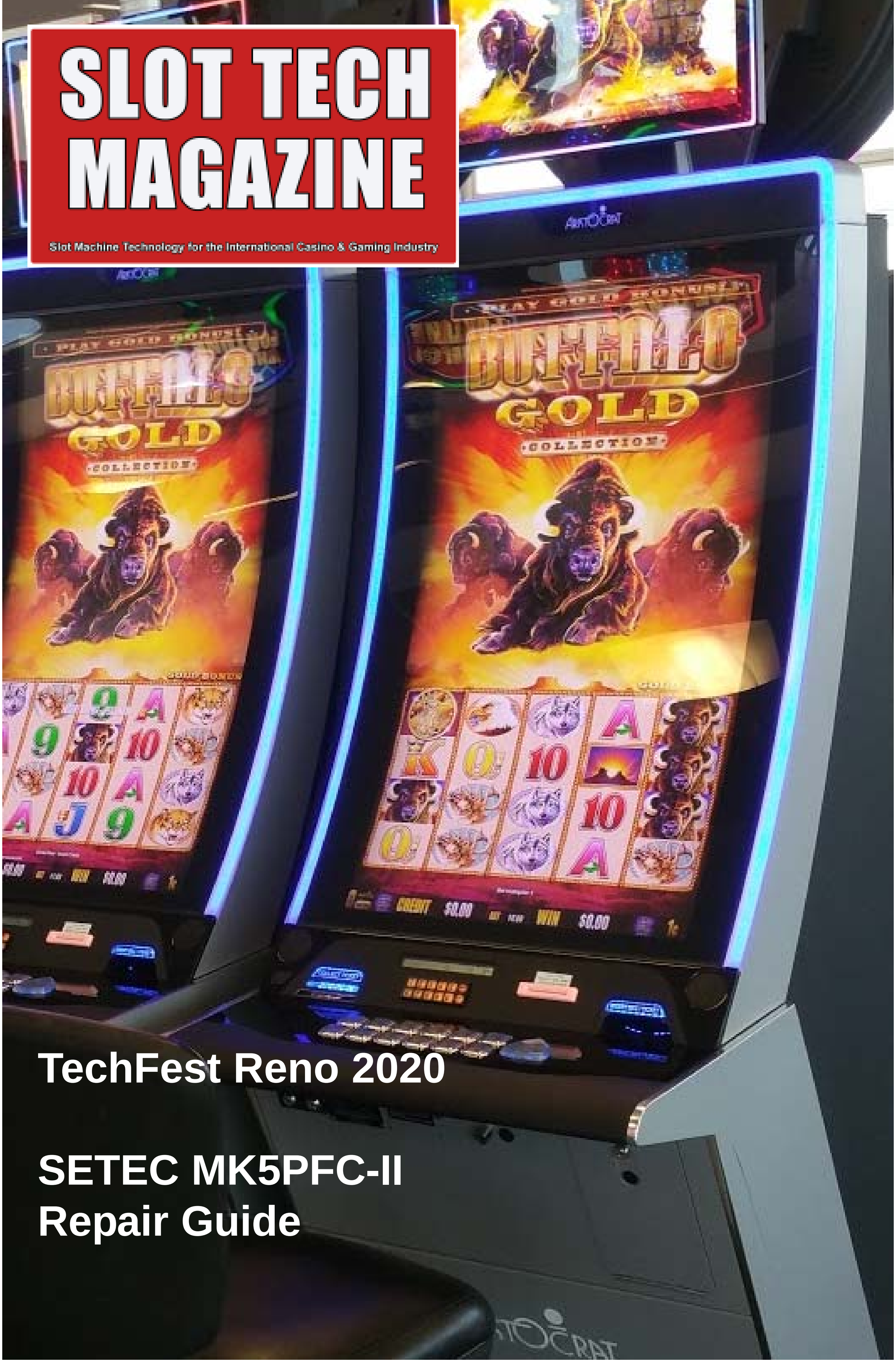
SLOT TECH MAGAZINE

Slot Machine Technology for the International Casino & Gaming Industry



TechFest Reno 2020

SETEC MK5PFC-II Repair Guide

TechFest Reno 2020

Peppermill Resort Hotel - March 31-April 2, 2020

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Ceronix-LCD Monitor Repair
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TechFest also includes instructions on LCD monitor repair and more, presented by Randy Fromm, publisher of Slot Tech Magazine and your host for the event.

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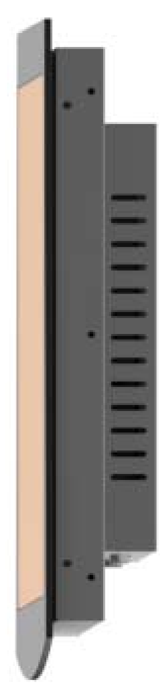
TOT2152EPC-V2 Ultimate Touch Monitor For Gaming

LCD monitors are a mature technology. A quick look at a modern slot floor and you can see the 3D space filled with giant monitors, often curved now with Scientific Games' TwinStar J43 Video Slot Machine cabinet and its "J" curve monitor or Aristocrat's Flame cabinet with its 55-inch "S" curve display and the like.

But there's still a lot to be said for "Normal" and that's what the TOT2152EPC-V2 Ultimate Touch Monitor For Gaming from **Shenzhen TMD Technology Co., Ltd** is. With great specs, a responsive (less than 10 milliseconds), projected-capacitance touchscreen that's Plug and Play ready for action and a straightforward, modular design that makes it easy to service, the TOT2152EPC-V2 is an obvious replacement choice for a reasonably-priced monitor that can be "dropped-in" when a flat, touchscreen monitor is required.

Naturally, the monitor features LED back-lighting. The LED Driver PCB is one of the four, small printed-circuit boards you'll find under the back shield. The other boards are the A/D PCB (featuring both VGA and DVI inputs, a nice LVDS connector and cable instead of a cheap ribbon cable connection to the LCD panel as well as through-hole, electrolytic capacitors instead of SMD capacitors. This will make future PCB servicing easier, should capacitor replacement be necessary), the USB/RS-232 interface PCB, and the touchscreen controller itself.

The unit features a 10 touch touchscreen. The touchscreen is built with Glass-Glass construction which uses a matrix of rows and columns of Indium Tin-Oxide (ITO) printed on sheets of glass. Voltage is applied in a common computational scheme called "addressing." When a conductive object, such as a finger, comes into contact with a PCT panel, it distorts the local electrostatic field at that point. This is measurable as a change in capacitance. If a finger bridges the gap between two of the "tracks," the charge field is interrupted and detected by the controller. This system is able to accurately track up to 10 simultaneous touches.



Product Specifications

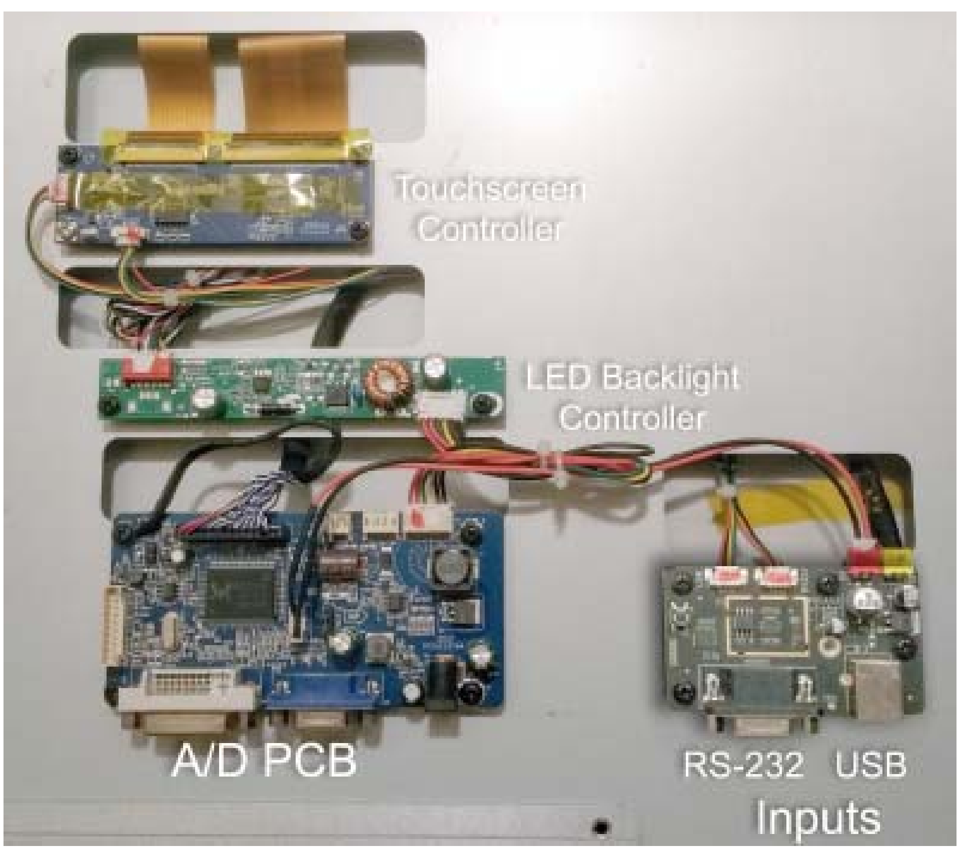
Drop-in replacement for SG Fusion Hybrid, SG Fusion Auto Roulette, SG Fusion Virtual Multi-game and SG Table Master Fusion
·1920x1080 Resolution 16.7M Colors LCD Panel With LED Backlight
·DVI + VGA Input Video Source
·DC-12V Input Voltage
·P-CAP 10 Points maximum Touchscreen With USB and RS232 Interface
·Touchscreen Supports Upgrade Firmware Via RS232 and USB Interface
·Certification CE, FCC, ROHS, etc.
Product Dimension 575mm x 336mm x 52.5mm
Net Weight 6kg
Package Dimension 670mm x 170mm x 440mm
Gross Weight 7.1kg

LCD Display
Number Of Pixels 1920 x 1080
Panel Size 21.5"
Active Area 476.0mm x 267.8mm
Pixels Pitch 0.24795mm
Display Colors 16.7M
Aspect Ratio 16:9
Contrast Ratio 1000:1
Brightness 250cd/cm2
Back-Light is LED lighting bar type

Touch Points 10 Points maximum
Touch Construction Glass-Glass
Viewing Angle Range H:170~178Deg. V:170~178Deg.

TouchScreen
Touch Technology P-CAP
Touch Sensor 52(X), 33(Y)
Touch Cover Glass T=1.8mm
Interface USB-B Female, RS232 DB9 Female
Luminous Transmission e”85%
Input Source Finger
Touch Accuracy 2mm(Central), 2.5mm(Edge)
Response Speed <10ms
Supports OS windows xp/7/8/10, Linux, Android, macOS
Humidity Operating: 10%-80% RH,40°C

Manufacture ROHS, ISO9001:2008
Technical Service customize protocol for USB and RS232 interface
Supports Upgrade Firmware Via RS232 And USB Interface



Certification Electrical CE,FCC,ROHS,etc.

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Setec MK5 PFC Version 2

Reverse Engineering Part 1: By Carey Treesh

(color schematic included at end of document for reference)
The Setec MK5 comes in two versions, the PFC1 and the PFC2. The PFC1 is outdated and rarely used anymore so this document will attempt to cover some of the operations of how the PFC2 power supply works based on my analysis. Not all questions are answered and not all problems are yet solved.

120/240 Volts AC IN:
This power supply uses an external filter board. I have found that for bench testing and repair, you can remove this part of the unit and connect a 120volt isolation transformer directly to the blade connectors on the main board. They are right next to the fuse and labeled blue and brown. Hot and neutral do not really matter with proper use of a bench isolation transformer and is required to perform any service/repair or bench testing in a safe manner.

ON-BOARD FILTER:
A typical use of coils and small value caps are used to filter the power line. This filter works along side the filter board to provide the best possible protection of the power line. The power supply itself is generally not affected by noise on the power line but it itself produces quite a lot of power noise during its operation, thus filters are used bring that noise to ground level so as not to effect other things plugged into this same ac outlet. This filtering is an FCC requirement as well as a UL listing requirement. Generally nothing goes wrong in this area. The only exception might be the 10 amp fuse sometimes blows if there is a major board failure.

LOW POWER STARTUP MODE:
Just after the filter stage is relay (k1) plus 1 NTC power resistor plus one more 10 ohm power resistor. At first power up, the AC line voltage passes thru both resistors and that limits the maximum amount of current the power supply can use from the line. This is done to protect the fuse from an in-rush of high surge current that will be preset during the charge up of the Vbulk (see boost converter). Once the power supply is up and running in this lower power mode, the relay is energized which by-passes the two resistors. This allows the power supply to use the full amount of current it needs from the power line. Lower power start-up mode is enough to get the unit started and after safety checks are done, then full power mode is engaged. This provides less heat and better power efficiency. It also improves the reliability of the unit and its parts.

FULL WAVE BRIDGE AC to DC:
The bridge is next marked as D1. This is a typical setup where the input AC voltage is converted directly to DC before being stepped down by a traditional transformer. Because line voltage is already high and gets directly converted to DC, it poses a high shock hazard. This DC is fed thru the boost converter circuit (purple shade on my drawing) and finds its way to Vbulk (C52). Note that this cap will hold high

voltage even with the power line removed. It does have a bleed off however, so no need to discharge it. Just wait about 40 seconds before handling the board.

BOOST CONVERTER

The DC voltage from the full wave bridge passes thru some diodes and a large coil (L5). At first the DC voltage charges up the Vbulk to the peak voltage on the AC sine wave (about 170volts DC). This 170volts feeds a few places on the board. The boost converter will boost this voltage to about 400 volts DC when active. It does this by using a high power mosfet (Q1 a Toshiba K2837). This mosfet when active completes a circuit to ground just after L5. During this “short circuit” all the DC voltage and power flow into L5. This causes a very strong magnetic field to build up. This short is quickly removed, and now the field collapses, inducing its own voltage which is in series with the main DC voltage, and they combine to make 400 volts DC which is stored in Vbulk. Q1 is controlled by the main processor, a Texas Instruments UCC28513. Pin 12 of this chip is the driver signal for Q1. D35 and D5 are Zener diodes which help to prevent too high a voltage signal on Q1. These can fail and should be tested, especially if Q1 Mosfet has shorted out.

Vcc POWER GENERATION:

The parts in the light blue area of my diagram are used to generate the primary side’s chip voltage known as Vcc. It takes the DC rail voltage from Vbulk as an input (170vdc to 400vdc) and converts it to about 13.5 volts DC and this power rail (red) is used to power all the chips on the primary side of the power supply.

U14 MAIN CONTROLLER CHIP: PFC

This is the main processor of the power supply. Its main job is to generate two “gate signals.” The first gate signal is on pin 12 and is used to drive Q1 in the boost converter. We call this side of the chip PFC, for power factor correction. Power factor is an electrical condition that robs efficiency from devices with coils or transformers. Some of this loss can be compensated for by using our own coils and careful timing of a driver signal in the boost converter. In order to get the timing just right the chip needs to monitor a few things. Pin 3 in green connects to a series of dropping resistors in pink (R147 R134 R133 R144 and R205). This voltage divider takes the 170- or 400-volts dc and drops it to a safe voltage the chip can handle. Based on the exact voltage it reads, it will vary the pulse width modulation on Q1 in the boost converter to compensate in the best possible way for power factor losses. You may also notice pin 3 also connects (in green) to pin 13 of chip U2. I will cover this later, it’s for safety shutdowns.

U14 MAIN CONTROLLER CHIP : FWD

This side of the chip is used to generate the PWM signal at gate 2 on pin 10. This signal connects to Q5 (A Toshiba K2611). This transistor also quickly closes a circuit to ground thru the primary windings (two of them) of transformer T1. The amount of pulse width (how long this Q is on) is determined by the chip, and it makes this calculation based on a few input pins on the FWD side (FWD means “forward converter” which is what this design is called). Two major signals are monitored. First on pin 8, the amount of current in amps is measured across R86 and passes through R185 to pad it down a little bit for the input to the chip. This current is generated when Q5 is active, and flows thru it and R86 and also thru T1’s primary windings. If the current measured gets too high, this will trigger an overload condition and the chip will shut down the drive signals to both Q1 and Q5 to prevent fire and damage to the board and its parts. The other major monitor is on pin 7 known as VERR. This is the amount of error in drive detected based on looking at the output voltage which should be exactly 24volts DC. If this output voltage is low, then the chip needs to increase the pulse width. If its too high, it needs to decrease the pulse width. It gets this voltage monitor via U4, an opto-isolator connected to the 24-volt regulation parts shaded in yellow.

SAFETY SHUTDOWNS:
The main chip has several signals that it’s monitoring, not only for the best possible efficiency but also for safety issues that might come up if a part should fail. A few of these monitors are located on the primary side of the board (The AC input side) and a few more are located on the secondary side (the DC output side of the board). Since galvanic isolation is required between both sides of the board, all of the safety monitors on the secondary side must sent to the chip via optic isolation. This includes the voltage regulation feedback (U4) plus several others that all combine into U5.

The U2 chip is a quad (4) operational amplifier. Each of these four separate op amps can compare two input signals. The idea is to compare a known good reference signal to the one we are trying to monitor. If there is any difference, this segment of the op amp will output a positive or negative voltage based on the difference in voltages on its two inputs. The main processor chip provides a reference voltage on pin 20 (yellow). This reference voltage can only be provided to chips/segments located on the primary side of the isolation. (See the gold line for division of primary and secondary side of the board).

U2 Seg 1: This one is looking at the 170/400 volt rail, after it’s been dropped to a safe voltage signal by the resistors R49 R33 R34 R48 and R32. This voltage is compared to the reference voltage (yellow). The output on pin 2 of U4 controls the brightness of the led in opto-isolator U6. The other side of U6 (on the secondary side of the board—pointed to by the brown arrow) receives this signal and uses it to control the drive voltage on the gate of Q9. The drain of Q9 (its output) connects to the “PF” line (orange) and I believe its used as a “power fail” signal to the slot machine telling it power is about to drop.

U2 Seg 2: This one uses the AC line voltage, passed thru a series of drop down resistors on both hot and neutral (or hot and hot if 240vac) {dark purple wires}. These combine into one voltage, converted to DC by D24 and this voltage is compared to the reference voltage provide by the main controller chip (yellow). This is tagged “AC OK.” This signal is fed to U2 SEG 4. (this gets tricky) see seg 4.
U2 Seg 3: This segment is comparing the signal provide by opto-isolator U5 to the “AC OK” signal provided by Seg 2. This opto-isolator is a combined result of all four segments in U3. The output of this segment influences the input on the last segment, Seg 4. (which is also the “AC OK” signal). I know, sorry it gets worse.
U2 SEG 4: From what I can tell, this is the final segment of safety monitoring for

many conditions at the same time. If any of the other segments fail their safety checks, then this Seg 4 will trigger the main controller chip via output pin 13, up the (green) wire to intersect with the VSense dropping resistors feeding pin 3 of the main chip. I assume the main chip will make necessary adjustments to the PWM on the boost converter gate drive pin 12, but if the signal on this green wire from the last safety op amp is too high (or maybe low) it will cause the main chip to shut down completely.

MORE SAFTEY SHUTDOWNS ON U3
The U3 chip lives on the secondary side, and as such can not take advantage of the main chip output of the reference voltage (yellow). As such, a new reference signal to compare to must be generated here on the secondary side of the board since that's where U3 lives.
U10 is small chip with Zener diodes that provide a fixed, highly accurate output voltage. In this case 5.0 volts is generated and will be used as the reference signal for all four segments of U3.

U3 Seg 1: The 24volt output rail is checked against the 5 volt reference. The output is used to feed the gate of Q7. Q7 trips state of the "OF" line (black dots). I'm not 100% sure what OF means, but I assume it's a power good signal (or maybe a power bad signal) that is fed to the slot machine. It's a different signal then the PF (orange) signal tho.

U3 Seg 2: This segment monitors the voltage drop across R122, a resistor that changes its value with temperature (I think). D27 isolates it from back feeding and causes only forward voltage from this resistor to Seg 2. It is compared to the 5 volt reference. The output is fed to U3 Seg 3.

U3 Seg 3: This segment is just a pass thru from the last segment's status. Seems redundant, but perhaps it gains some "output power" making the Seg 2 signal stronger? In any case its output feeds directly to the U5 led. As far as I can tell, U3 Seg 3 is just used as an amplifier for the over temp signal, and it's itself is not checking anything, only passing thru what it already got.

U3 Seg 4: This segment seems to be comparing the main 24-volt output against the 5 volt reference. Its output signal is also connected to the U5 led.
U5 LED:
Since all of U3's safety shutdown monitors live on the secondary side, all of the monitored signals for over-temp, and AC power fail, and 24volt primary fail and even 24volt aux fail feed into each other and terminate at U5. I'm not 100% sure, but it's a safe bet that U5 is pretty much a "go or no go" signal. That would mean the led must be on, or maybe off to allow the power supply to run. In either case, this led shines on the receiver part of U5 located back on the primary side just after the "ac OK" check. In this manner all the safety checks on the secondary side, as well as all the checks on the primary side combine together as one big final "go or no go" signal that is output from U2 Seg 4, and feeds into the same pin on the main controller as VSense (green wire).
I think then, U2 seg 4 has the ultimate control over safety shut downs as it collects pass/fail status from all the other safety monitor segments, and if any of them are a fail status, then Vsense gets either flooded with voltage forcing a shutdown, or is pulled to ground keeping it from seeing the voltage it wants to see,

also forcing a shut down. But I'm not 100% sure which yet.

24 VOLTS DC OUT Rectification and Regulation:

The secondary windings of T1 produce two isolated, separate AC outputs. The main output voltage is located right in front of the big yellow shade on the diagram. T1 (pink box) is rectified by D30. C88 and C25 are the main filter caps for the main 24v output. (C25 on the schematic is located near U11) This DC output provides power to the regulator section in yellow. The regulator uses U9 to generate a fixed 5.0 reference voltage. The voltage passes thru R92 into the led side of U4. The 24volt rail provides the power to the other side of the led. In this manner the led gets two positives and no ground to complete the circuit. Current will flow from the higher voltage (24) to the lower voltage (5). The amount of current depends on R92 and the LED's resistance as well. The result will be a certain amount of current giving off a certain about of light. Since the 5 volt side is fixed at 5.0 volts and won't vary, the 24 volt side will however vary with the amount of load put on it. But if that 24 volts drops, the amount of light given off by the LED drops with it. This amount of light is collected at the U4 receiver side and is converted to a VERR voltage. This is fed to pin 7 of the main chip. This way we can still have 100% galvanic isolation between input side and output side, yet still maintain perfect voltage regulation.

24 DC OUT AUX

Another secondary of T1 located in the bottom left in pink box generates a 24-volt DC signal by first passing thru a set of series resistors and gets ½ wave rectified by D26. The main filter is C20. This aux voltage is only used to provide Vcc for U3. Since it is not regulated in any way, it might be safe to assume voltage changes on this rail will cause the LED of U5 to also change. If this is true, then U5 and thus U2 seg 3 and U2 seg 4 might play a role in voltage regulation for this aux power rail, as well as trip the unit into shutdown if any safety checks fail. This rail is used only internally by the parts of the power supply itself and is not provided as an output. Its also possible that no voltage regulation is required on this rail, since the chips probably will operate correctly even if the voltage is not regulated. Not sure yet.

U11 Q6 Q7 Q309 Mystery:

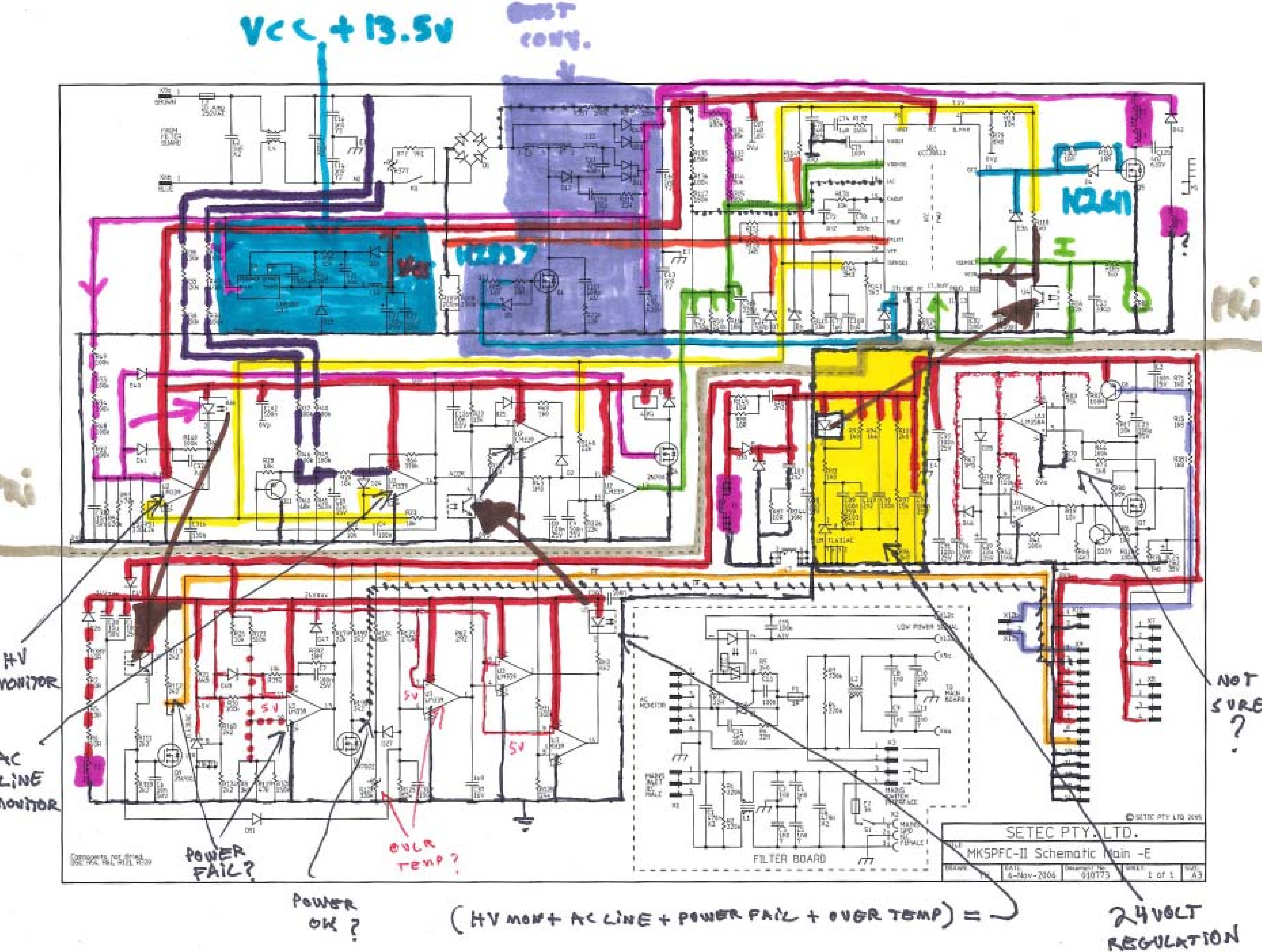
This section is for some special purpose that I don't fully understand what it's there for or what it's trying to do. Q6 looks like power switch of some sort that would allow power to flow from the main 24 volt rail into the Vcc of U11. The base of Q6 (purple wire) comes from the external connector. I can only assume then that the slot machine activates this part of the power supply. Assuming that's true, U11 can now get power. U11 is a dual op-amp with 2 segments. Segment 1 is comparing a voltage that comes from the power rail that gets activated by Q6 and checking it against a voltage at the drain of Q7. The output of this is fed into the input of Seg 2 and compared to a feedback voltage from its own output (??!?!??!) also its output feeds the gate of Q7 (??!???!?!). The drain of Q7 also feeds out to pin 2 of connector X8. I kinda feel like "Towely" from "South Park" trying to figure out this loop.

The only conclusion I can give is that connector x12b1 pin 1 sends a signal into this thing and an output signal is collected. These signals are voltage based and are provided by and to the slot machine.

However, I don't even see any connectors on this board with the markings "x9 or x11b" which are what these two wires are labeled as? There is a wire from this area to X8 however. So this must have something to do with the X7 and X8 light connectors? If these signals are used to control power to the light, I don't see how?

Zero Crossing:
On the filter board are some minor electronic parts that monitor the power line for when the 60 Hz AC sign wave crosses the zero-voltage point and starts to go negative. This is the ideal point to fire up an AC monitor (display) because heavy voltage sag and current draw will be at the lowest possible point. I'm not sure if this power supply is still used to provide 120/240 volts AC to power the monitor or not? I was told it used to run a CRT monitor?! Wow. I do see a small connector with a blue and white wire going from the main board to the filter board. This connector is marked X11, and I assume its just to provide some Vcc to run the electronics on the filter board to monitor zero crossing, but I'm not sure.

Repair tips:
Vbulk seems to a common fail point. This causes dirty power which can cause major problems for all the parts on the board. Remove and test Vbulk for bad ESR. Often times you wont even need to test it, as it will have leaked out its guts already. Check Diode D42, a snubber used on T1. If its shorted, you will never get this thing running. Its OK to remove it while bench testing. A new one should be put back in though before returning it to service. Removing C125 makes it a simple job to remove and insert D42. Check U13 in the Vcc section. Ohm it out in circuit, ignore the shorts between the bottom left and right pins, this is normal, all other values should be over 20K ohms, if not replace it. Check D43 for shorts. Check L10 for short/meltdown. It should read 10 ohms. Check Q1 and Q5 for shorts. Replace if needed, don't remove the heat sink, no need to. C25 and C88 often need to be replaced. And check the main processor chip for physical damage. Not seeing any, ohm it out with pin 1 as a reference to all other pins on opposite side of chip. All values should be over 100K ohms. This is not a prefect test, but 90% success rate with it. I'm still working on a good procedure to locate other bad chips and test the parts around those chips. If both Q1 and Q5 are shorted, I have not had much success fixing this board. I would assume that is because very small parts are damaged, or possibly other chips then the main and Vcc generation chip. **-STM**


VCC + 13.5V
BOOST CONV.
HV MONITOR
AC LINE MONITOR
POWER FAIL?
POWER OK ?
OVER TEMP ?
5V
(HV MON + AC LINE + POWER FAIL + OVER TEMP) =
24 VOLT REGULATION
NOT SURE ?
FILTER BOARD
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