LCD Color Monitor Hands-On Tech School - Agenda

A. Introduction/Tech School Objectives

B. Equipment Familiarization
- LCD Color Monitor Trainer
- Sencore Test Equipment

C. LCD Color Monitor Theory
- Block Diagram/System Overviews
- Understanding LCD Display Technology
- LCD Color Display vs. CRT Displays
- Testing LCD Color Monitor for Bad Pixels
- Digital Signal Processing
- Analyzing Differential Signals
- VGA & DVI Inputs
- Display Data Channel (DDC)
- Testing the AC Power Adapter or SMPS

D. LCD Color Monitor Troubleshooting
- Main Signal Processor & Control Circuits
- LVDS Interface
- LCD Panel
- LCD Display Backlight/CCFLs Theory
- Backlight Inverter Power Supply Theory
- LCD Color Monitor Troubleshooting

E. Backlight Inverter Power Supply
- Backlight Inverter Theory
- Performance Testing/Symptoms
- Luminance (Y) Measurements – ColorPro
- Backlight Inverter Troubleshooting
- Testing with a Bench DC Power Supply
- Replacing CCFLs or Inverter Power Supplies

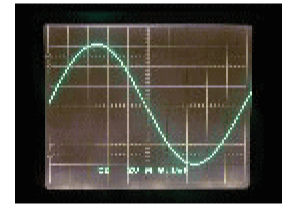
F. Color Monitor Alignment
- User Control Adjustments
- Color Temperature Alignment

We the willing, led by the unknowing, are doing the impossible for the ungrateful.

We have done so much for so long with so little, we are now qualified to do anything with nothing.

sign seen in tech shop

11-Golden Rules of Safety



1. **Anything with a AC plug must go into an isolation transformer.**

2. **Remove all jewelry (rings,watches,chains, hanging I.D. Cards) when working on anything electrical or electronic.**

3. **Always hook instrument *ground* (Black) connection up first.**

4. **Only one hand touching chassis or circuit components; preferably right hand; with fingers pointing up.**

5. ***Never* place one hand on one piece of electronic equipment then one hand on a separate piece of electronic equipment.**

6. **Always use Safety Ground Strap when working the Bench or on site.**

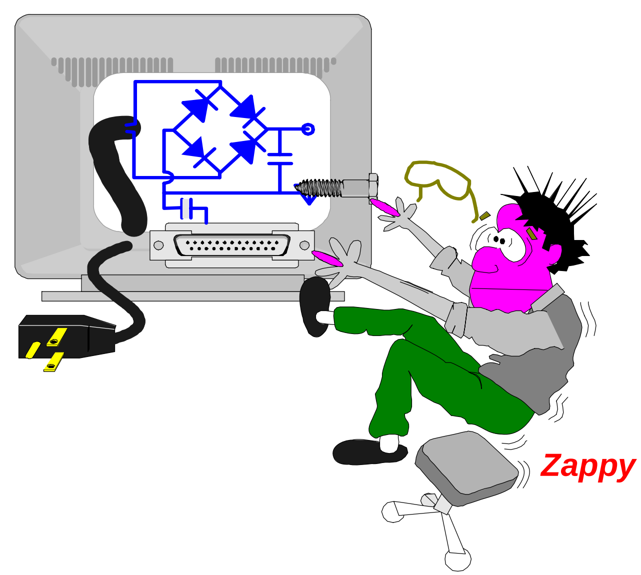
7. **When working with an Electronic Trainer with Trouble Switches, turn power to Trainer off, switch in Trouble Switch, turn Trainer on.**

8. **Electronics and liquids do not mix. (no drinks on working benches please)**

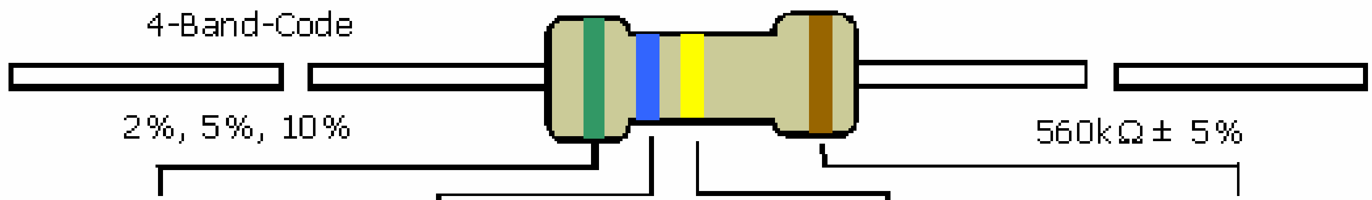
9. **Use *all* senses *all* the time. See, hear, feel, smell or sense something not right, power down Bench or product under test.**

10. **Power Down Bench when leaving for any period of time.**
    (preferably with one Bench Master Power Switch)

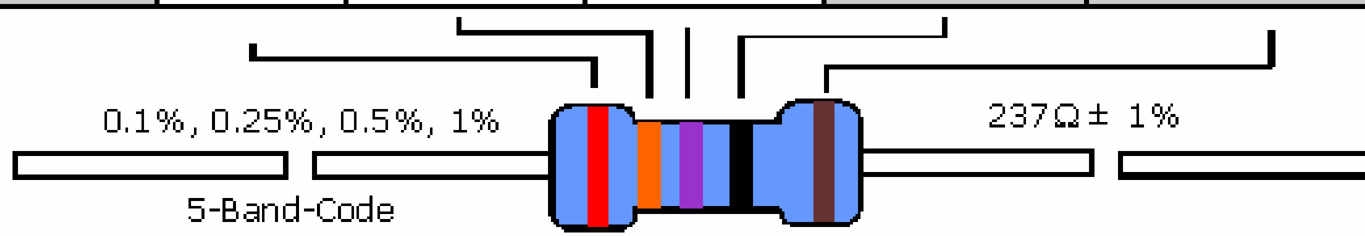
11. **Don't Feel Well? Take a Break or Go Home!**



SC3100 - ohmmeter



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	±0.5% (D)
Blue	6	6	6	1MΩ	±0.25% (C)
Violet	7	7	7	10MΩ	±0.10% (B)
Grey	8	8	8		±0.05%
White	9	9	9		
Gold				0.1	± 5% (J)
Silver				0.01	± 10% (K)



Electronix Express / RSR
http://www.elexp.com

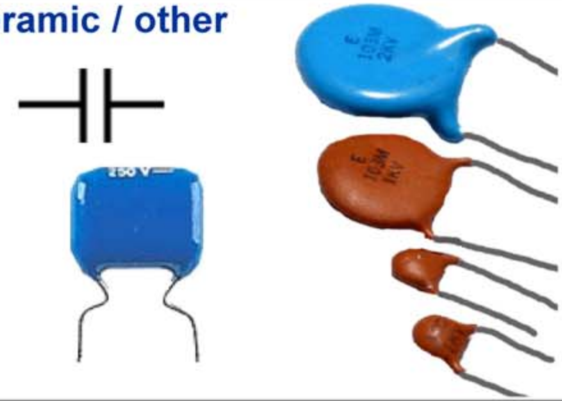
1-800-972-2225
In NJ 732-381-8020

Component Identification Guide

NOTE: Size and color of components vary. Pictures are not to scale.

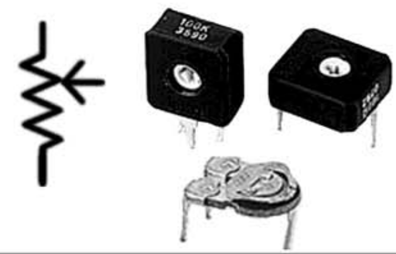
Capacitor - electrolytic (polarized)

ceramic / other

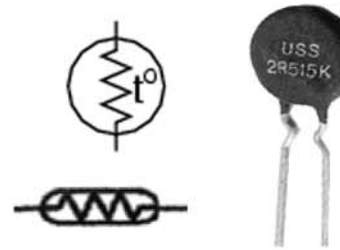


Resistor - fixed

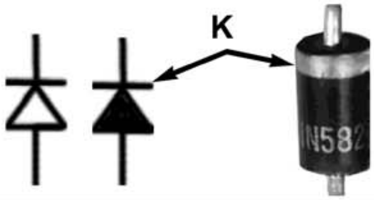
Resistor - adjustable



Thermistor / PTC

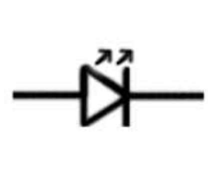


Diode - rectifier (polarized)

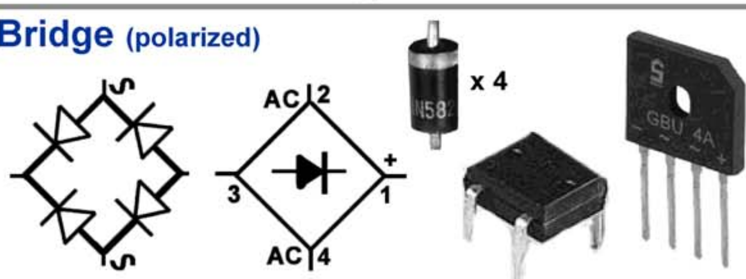


Diode - Zener (polarized)

Diode - LED (polarized)

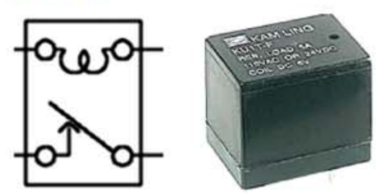


Bridge (polarized)



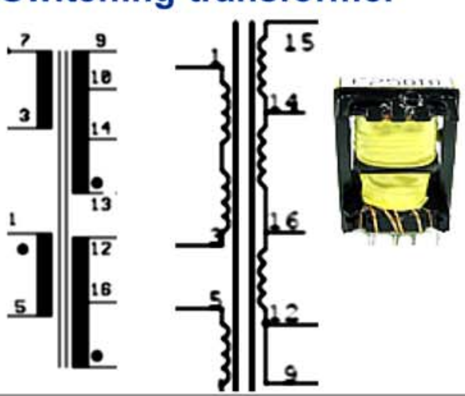
Fuse

Relay

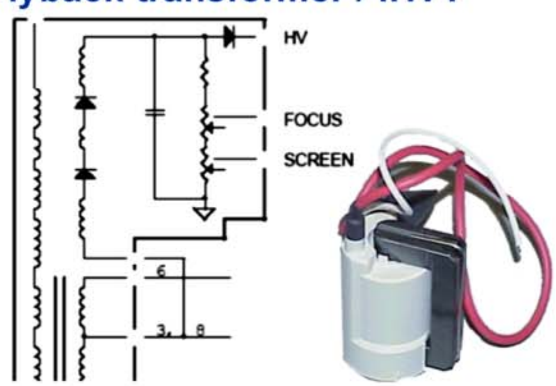


Transformer

Switching transformer



Flyback transformer / IHVT

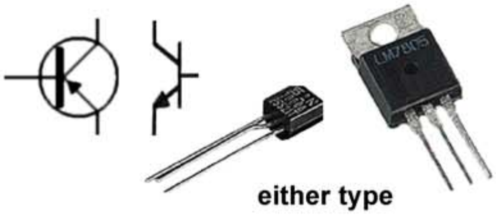


SENCORE

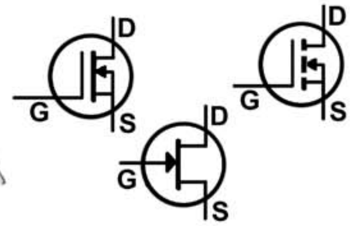
ELECTRONIC TEST EQUOIPMENT

1-800-SENCORE www.sencore.com

Transistor - bipolar

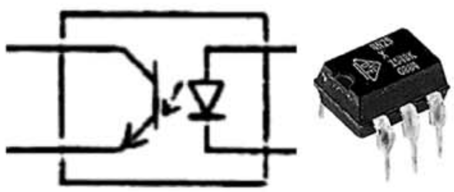


Transistor - FET

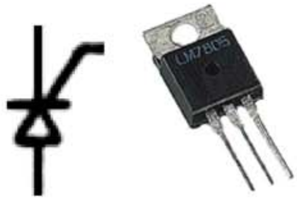


H.O.T - internal damper

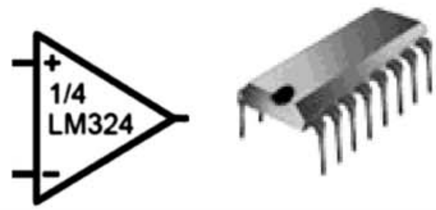
Opto Isolator



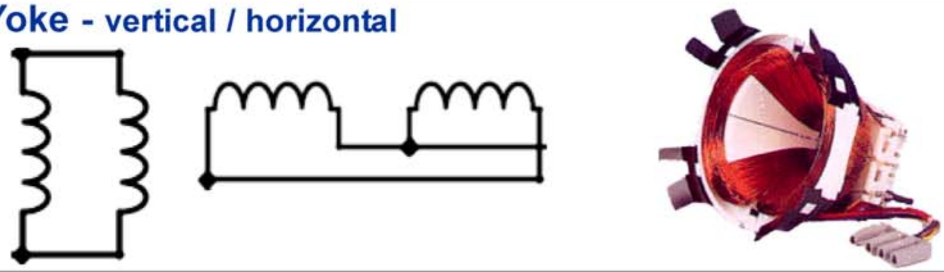
SCR



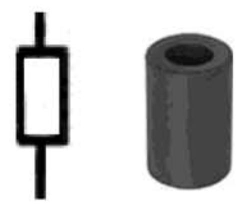
Comparator IC



Yoke - vertical / horizontal



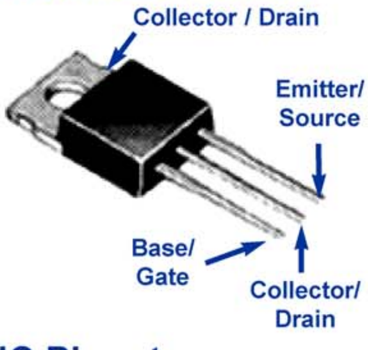
Ferrite Bead



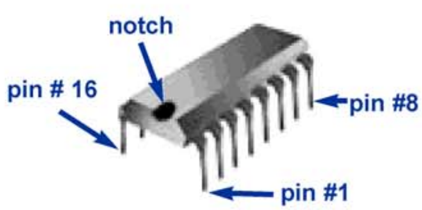
Coil / Inductor - fixed

Coil - adjustable

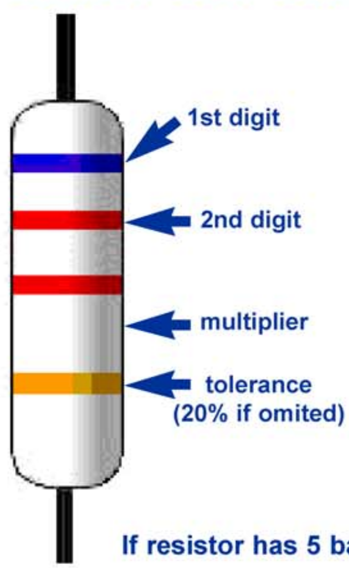
Transistor pinout



IC Pinout

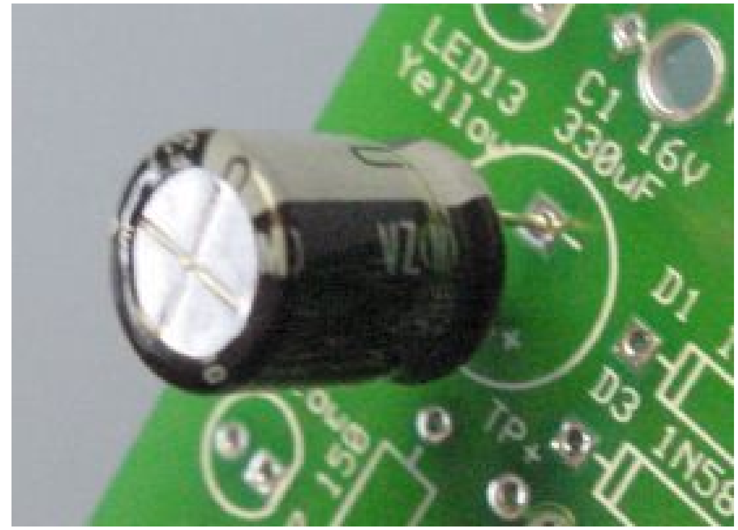


Resistor color code



Color	Value	Multiplier	+/- %
Black	0	1	-
Brown	1	10	1%
Red	2	100	2%
Orange	3	1000 (1k)	-
Yellow	4	10,000 (10k)	-
Green	5	100,000 (100k)	0.5%
Blue	6	1,000,000 (1M)	0.25%
Violet	7	10,000,000 (10M)	0.1%
Gray	8	Gray	0.05%
White	9	White	-
Gold	-	0.1	5%
Silver	-	0.01	10%

If resistor has 5 bands, the 1st three are value "digits"

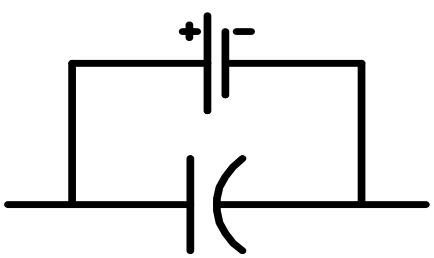


Capacitors fail in one of four ways

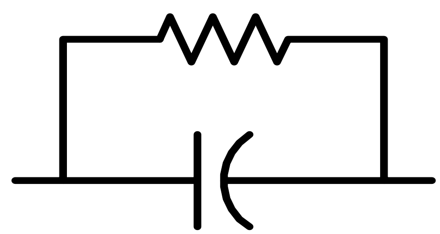
- Value Change
- Excessive dielectric absorption (DA)
- Excessive leakage
- High equivalent series resistance (ESR)

Value Change

ESR



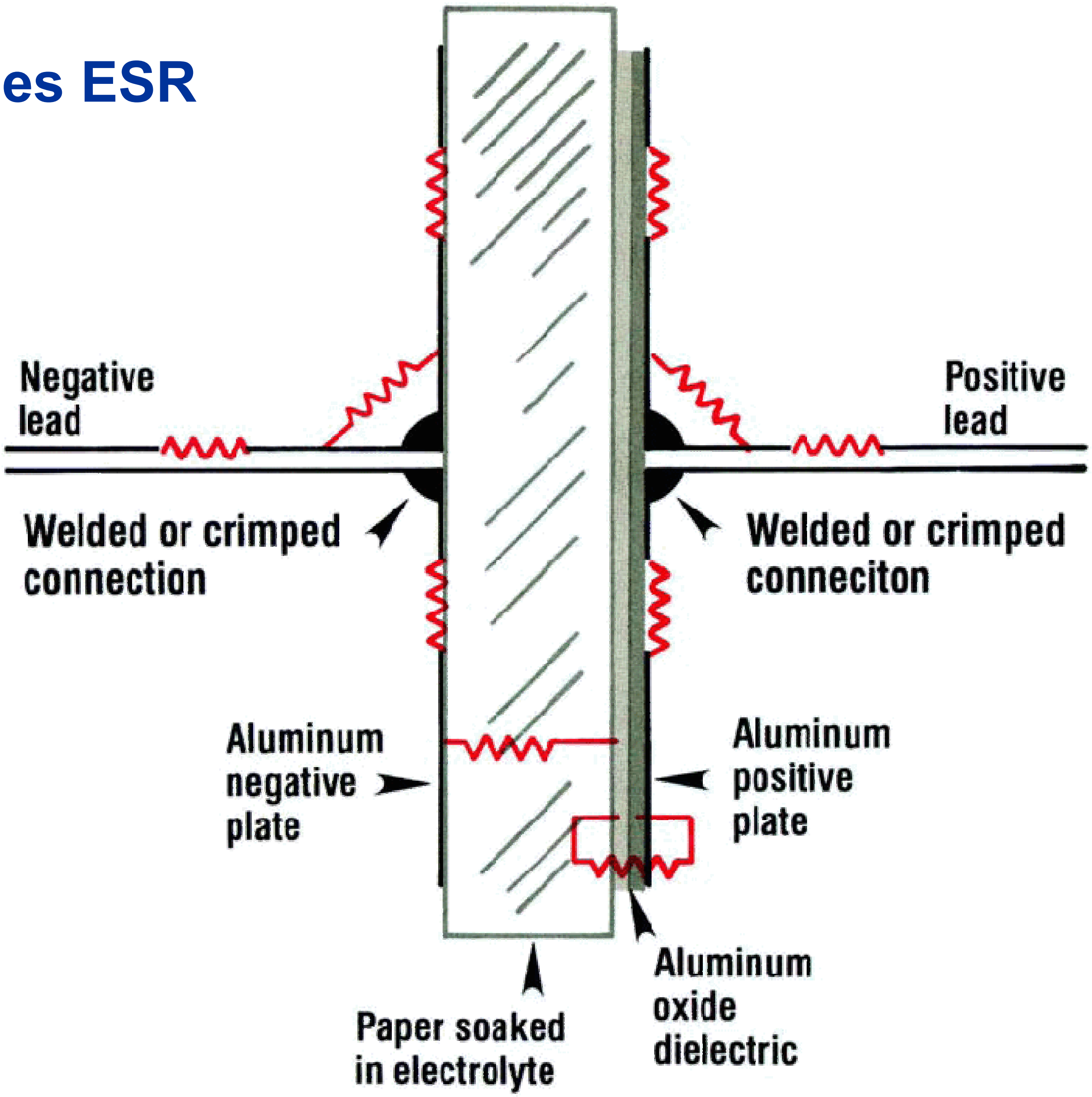
Dielectric Absorption



Leakage

A value change alone is rare

What causes ESR



Using the LC103 measure and record the following capacitors on the PWM board with the LC103's in-circuit test.

C21= 22uf/35V Measured Value ____________ ESR _________ Message __________

C2 = 470uf/220V Measured Value ___________ ESR _________ Message __________

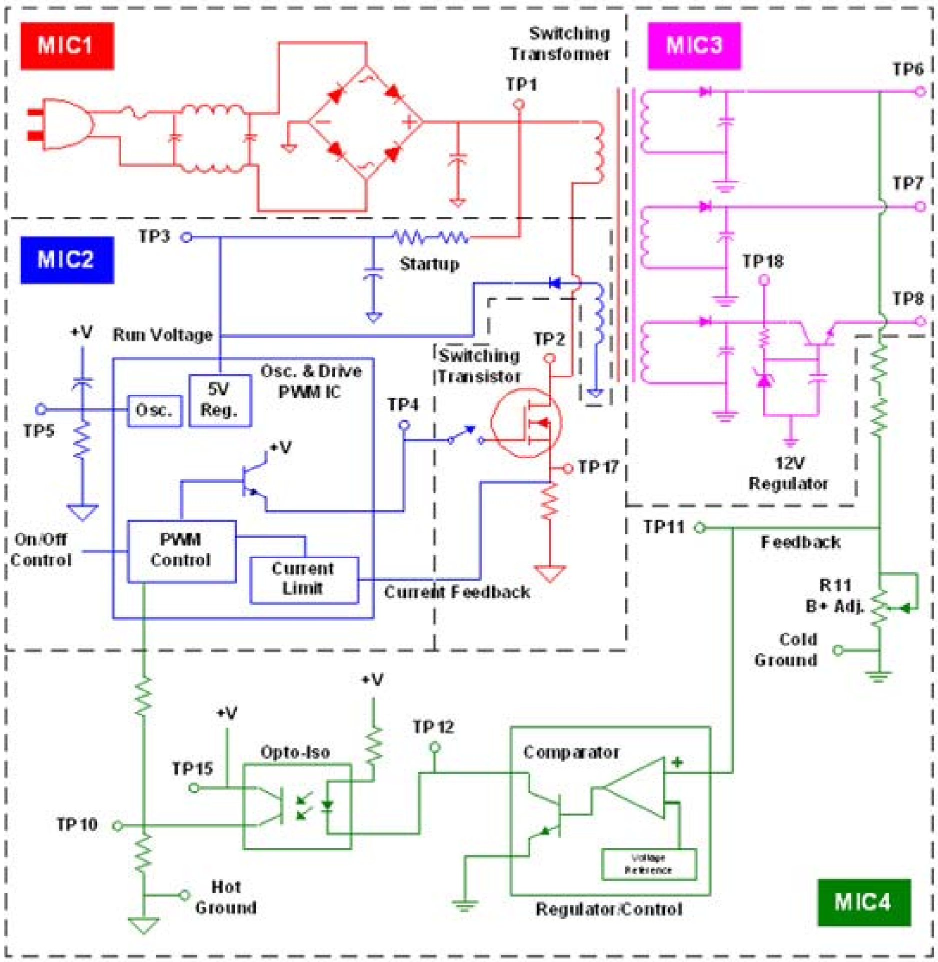
C4 = 10uf/50V Measured Value _____________ ESR _________ Message __________

C12= 220uf/25V Measured Value ____________ ESR _________ Message __________

C14 = 47uf/100V Measured Value ____________ ESR _________ Message __________

Efficient SMPS troubleshooting requires the use of a thorough method to analyze components

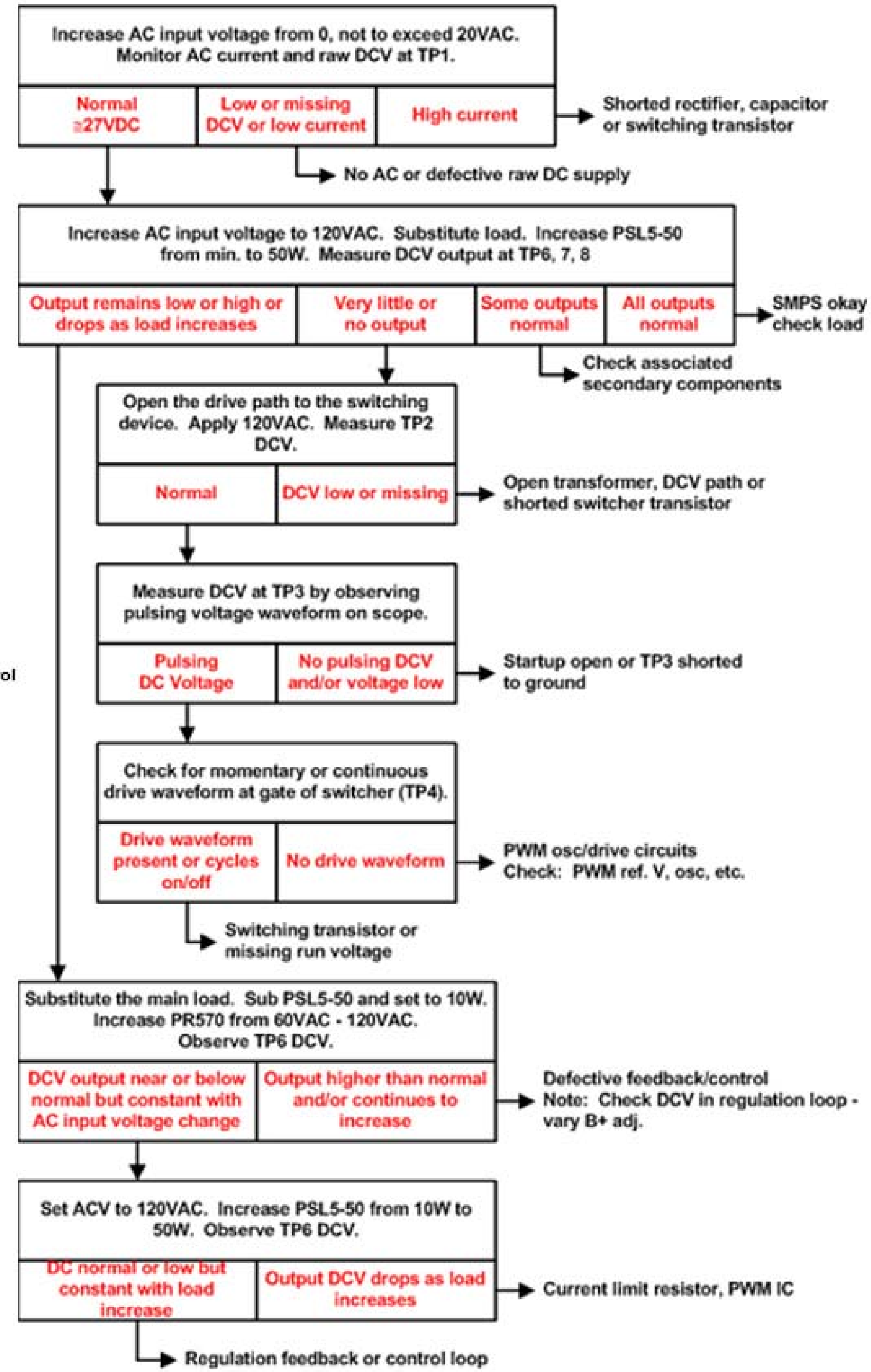
Simplified Pulse Width Modulated (PWM) SMPS



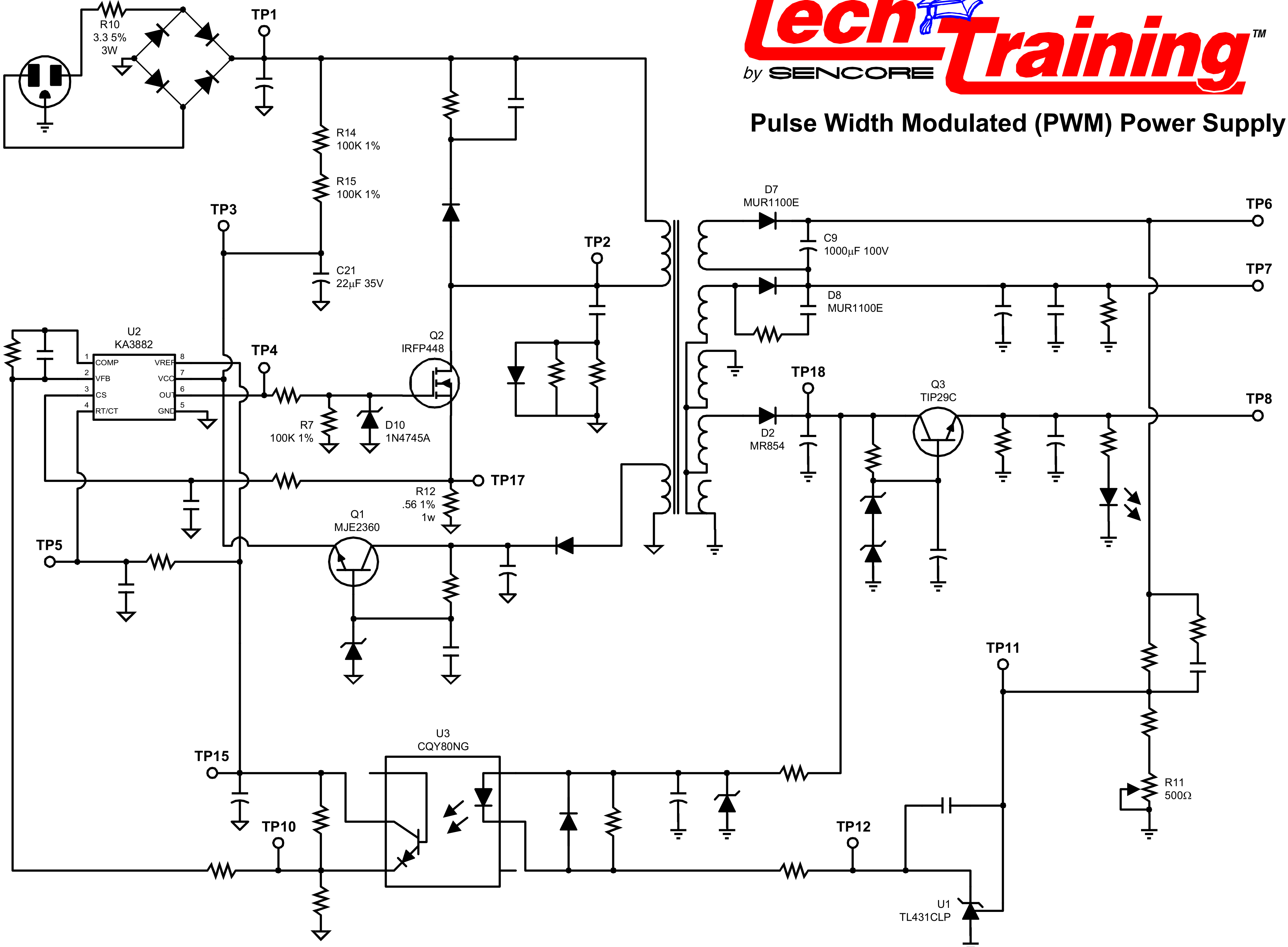
- Raw DC Supply
- Regulated DC Outputs
- Primary DCV
- Startup DCV
- PWM Oscillator & Drive
- Regulation Feedback Control
- Current Control

TP1 157.3 VDC	TP5 1.9 VDC	TP11 2.5 VDC
TP2 157.3 VDC	TP6 150.0 VDC	TP12 9.28 VDC
TP3 15.3 VDC No Waveform	TP7 92.0 VDC	TP17 0.06 VDC
TP4 2.0 VDC	TP8 12.5 VDC	TP18 24.6 VCD
	TP10 2.28 VDC	

Troubleshooting Tree

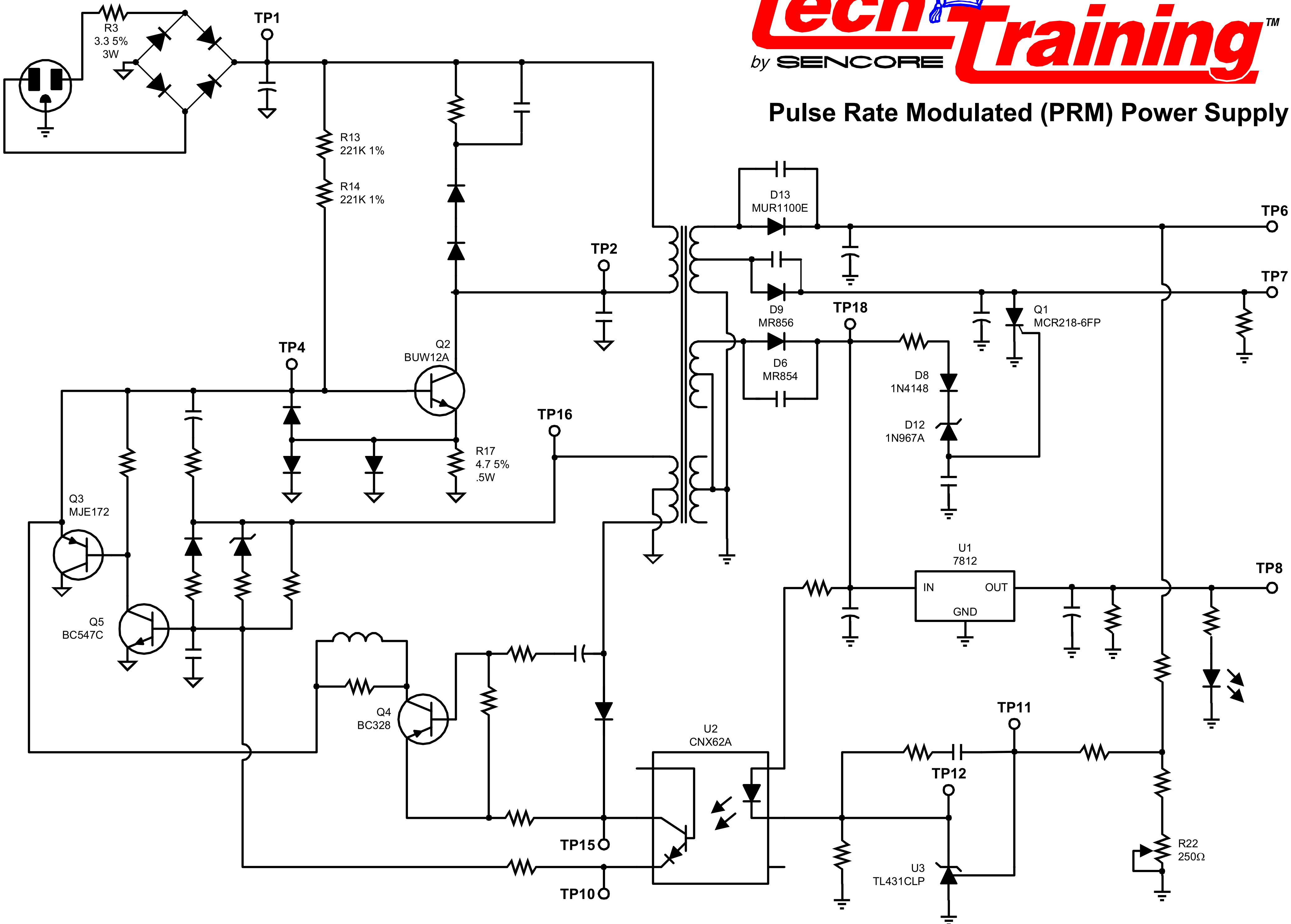


Pulse Width Modulated (PWM) Power Supply



Tech Training by SENCORE

Pulse Rate Modulated (PRM) Power Supply



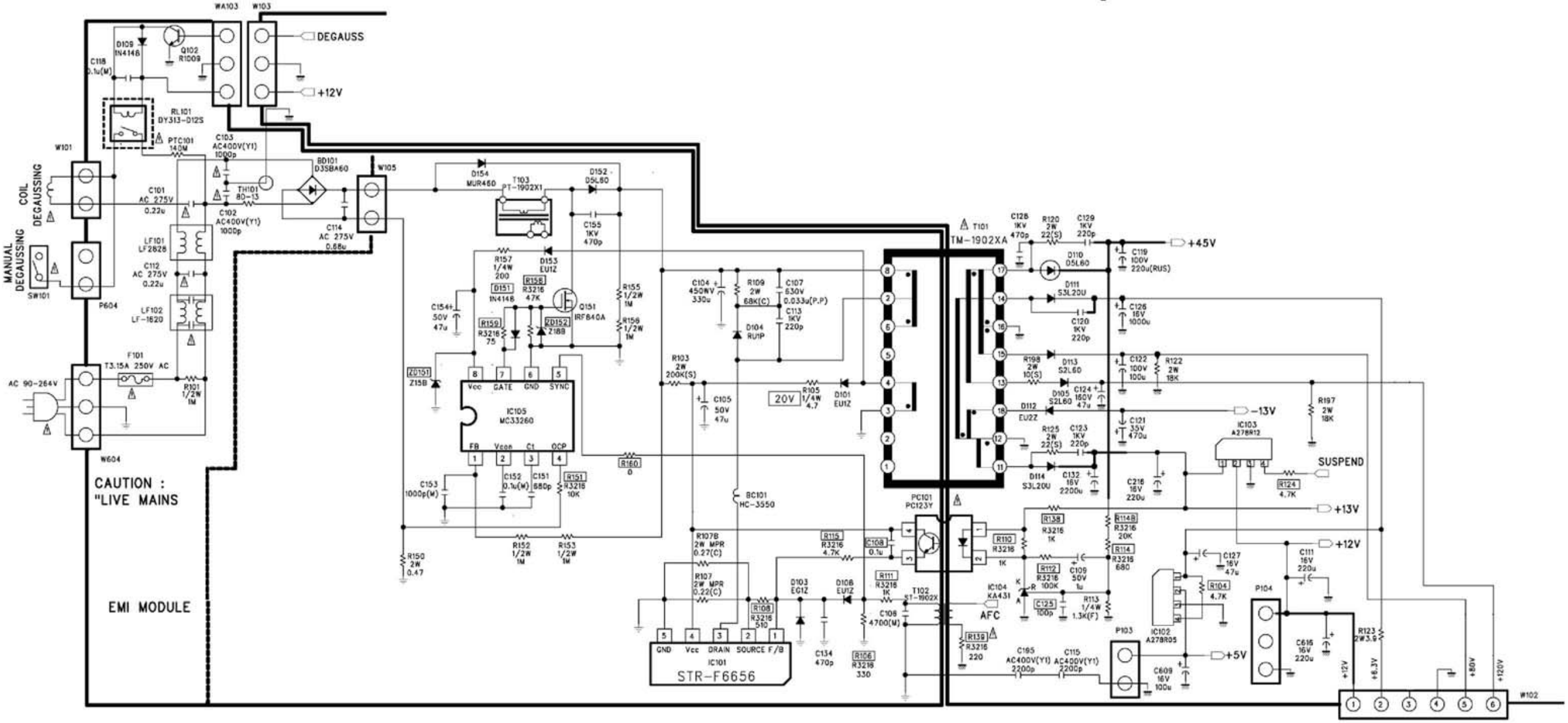
SMPS Activity: Homework - Mark the following test points and components

Main Switcher

- Degauser Posister
- Switching Transformer
- Bridge
- TP1
- TP2
- TP3
- TP4
- TP5
- TP6
- TP7
- TP10
- TP17

Power Factor Correction Switcher

- Switcher Transformer
- TP1p
- TP2p
- TP3p
- TP4p
- TP5p
- TP6p
- TP17p



Tovis Power Supply Schematic

TOVIS

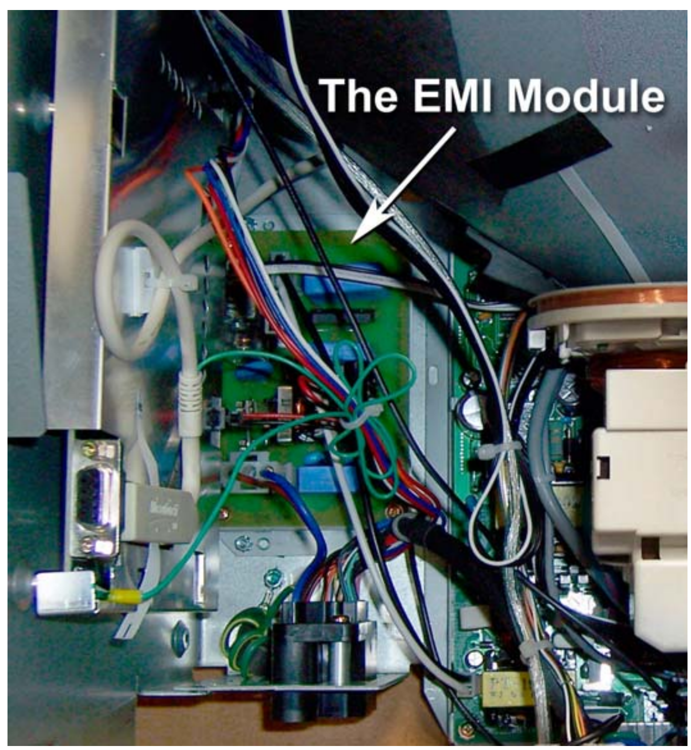
Part 2 - The Power Supply
An Introduction to Digital Monitors

Let's begin our detailed look at the Tovis digital monitor with the power supply. In fact, let's go back to the very beginning, at the AC (mains) input of the monitor. Right away, we see a notable difference between this monitor and the others we are used to repairing. Rather than connecting to an AC input connector on the deflection PCB, the AC input is connected to a separate "EMI Module." This is a small PCB upon which is mounted the components that we typically associate with the suppression of electromagnetic interference: AC input capacitors (C101, C102, C103, and C112) and the line filter itself. The engineers at Tovis have really taken this EMI suppression seriously, as there are two stages of EMI line filters (LF101 and LF102) in series. Nothing's going to get out of this monitor's SMPS and on to the AC power line, that's for sure. These components are typically low-to-zero failure devices.

Also included on the EMI Module is the degaussing circuitry. Unlike older, passive ADG (automatic degaussing) circuits, this one actually has a bit of active circuitry added that allows the ADG to operate under CPU control. It's a simple relay circuit that uses a transistor (Q102) as a "ground switch" to energize a relay coil. The base of the transistor is driven by the "degauss" output of IC801. What could be simpler?

Although we can now use an active control to turn the degaussing coil on and off, we still require a PTC thermistor (PTC101) in series with the degaussing coil. The degaussing coil's magnetic field can come on like a lion but it must leave like a lamb. That is to say, we cannot simply turn the coil off. The rapidly collapsing magnetic field would have just the opposite effect that we require, magnetizing the shadow mask of the CRT instead of demagnetizing it.

The positive temperature coefficient thermistor has a low resistance when it's cold but a high resistance when it's hot. As soon as the degaussing coil is energized, current flows through both the PTC and the degaussing coil which, as you can see, are in series each other. Of course, when current flows through a resistor, it generates heat and as the PTC heats, its resistance increases, slowly choking off the current to the degaussing coil. After a predetermined length of time to allow the PTC to reach its maximum resistance (but with no actual sensing involved) IC801 says "enough already" and removes the base voltage from transistor Q102, de-energizing the relay and removing power from the degaussing coil.



As with all such circuits, the degaussing coil will not operate again until the PTC thermistor cools off. However, unlike older designs, the PTC in this type of monitor does not require a "self-heating" element that keeps the PTC hot during monitor operation. Once the monitor has been degaussed (either automatically at start-up or manually) and the relay has dropped out, the PTC begins to cool and will be ready to go again in just a few minutes. A side benefit to this is that we save a watt or two of power as well. Energy saving is important in a monitor. There's no sense wasting power if we can find a somewhat "hi-tech" way to reduce the overall power consumption. You'll see in just a moment how the Tovis monitor carries this energy consciousness one step further.

Also included on the EMI module is the bridge rectifier (BD101) with an NTC thermistor (TH101) in its return path. The NTC thermistor is, of course, for inrush current protection as featured in the December 2004 issue of Slot Tech Magazine (page 33 - What a Rush!). Following the bridge rectifier, a .68 microfarad capacitor that is yet another link in the chain of EMI suppression.

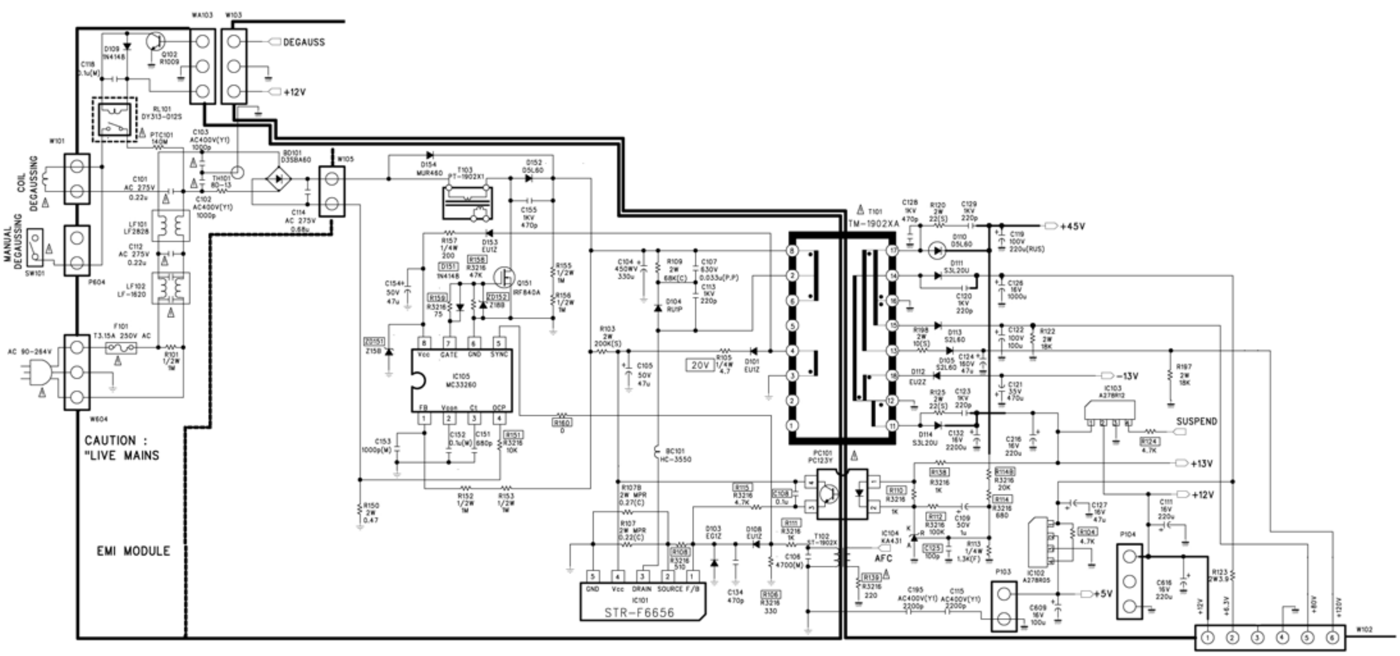
This EMI Module is starting to look a bit like a power supply but let's leave the EMI module now and make our way to the main deflection PCB of the monitor, where we see a very interesting new development in monitor SMPS design.

Think for just a moment about every power supply you have seen in your life as a technician. Whether we're talking about linear power supplies or switched-mode power supplies, what component almost always follows immediately after the bridge rectifier? It's the filter capacitor, of course. Look at a thousand different designs and you'll see it again and again: AC input connects to diode(s) followed by a filter capacitor.

However, in this design, the positive output of the bridge rectifier (at W105) is not connected directly to the positive terminal of the primary filter capacitor (C104). There are two paths that the output of the bridge rectifier can follow.

One path passes through diode D154 and then to C104. But why do we need the diode? It's already DC, isn't it? Sure it is. It's the output of a bridge rectifier and bridge rectifiers turn AC into DC. Is the current being "double-rectified" or something? Seems mysterious, doesn't it?

The answer lies down the other path so let's go back to the positive output of the bridge rectifier (at W105) and follow it straight across to what appears to be the pri-



mary winding of a transformer (T103) that is turned sideways, with nothing at all connected to the secondary winding. From the right side of this transformer winding, we can follow the current path through diode D152 and then to the positive lead of our friend the filter capacitor. What is going on here? Why are there two paths and why do we have the "extra" diodes?

Harmonic Currents and Active Power Factor Correction

If you're a regular reader of Slot Tech Magazine, you know all about harmonics and switched-mode power supplies. You know about the power-sapping third harmonic and how it robs your casino of power. If you need a refresher, the topic was covered extensively in the August 2004 issue.

Harmonic currents are a direct result of the way in which a switched-mode power supply (SMPS) draws current from the system. The input circuit of an SMPS is a bridge rectifier that changes the 120 volt AC input to DC. A capacitor smoothes this DC to eliminate voltage ripples and the resultant DC bus has a voltage of about 170 volts when the AC rms input is 120 volts. Although the AC voltage is a sine wave, the rectifier draws its current in spikes as shown in Figure 3. These spikes require that the AC supply system provide harmonic currents, primarily 3rd, 5th and 7th. These harmonic currents do not provide power to the SMPS, but they do take up distribution system capacity. The principal harmonic current is the 3rd (180 Hz) and the amplitude of this current can be equal to or even greater than that of the fundamental current.

The power supply used in the Tovis monitor is really two power supplies in one. At a glance, even a novice technician will recognize a standard SMPS design in power transformer T101 and its associated PWM controller/MOSFET, this time as a single module, IC101, an STR-F6656. The unregulated, filtered DC enters pin 8 on the primary winding of the transformer. The other end of the

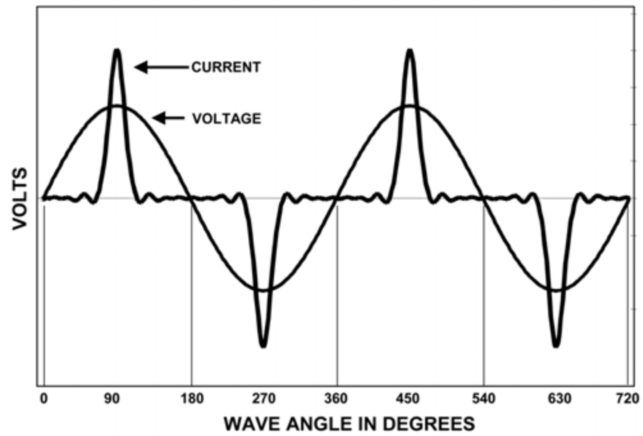


Figure 3. - Although the AC voltage is a sine wave, the rectifier draws its current in spikes

primary (pin 2) is connected to the drain of the MOSFET that's inside the STR-F6656.

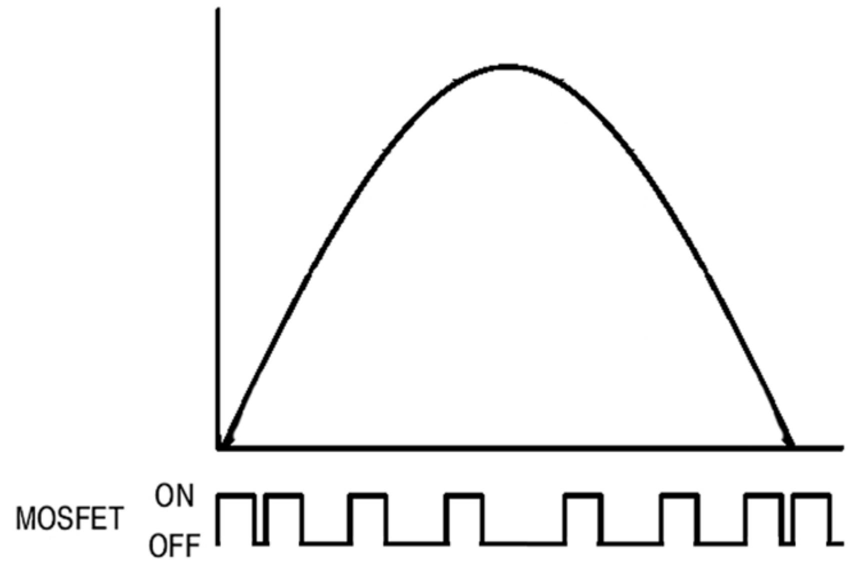
The source, as usual, is connected through a fraction of an ohm resistor (.22 ohm is typical) to ground. This is our over-current protection (OCP) detector. If too much current passes through this resistor (due to a shorted load, for example) it develops a substantial voltage due to IR drop. When IC101 see this voltage between its source and ground, it says to itself "Holy Mackerel! There's a short somewhere!" and it turns itself off by removing the voltage from the gate of its internal MOSFET. About once a second, the STR-F6656 will try turning itself on, see the voltage and turn itself back off. That is what creates the ticking sound that you hear in a monitor with a shorted horizontal output transistor. It's the OCP in action.

The second power supply is really the first power supply! Look at the circuit made from MOSFET Q151 and its associated controller, IC105. It kind of looks like it is its own SMPS, doesn't it? However, the drain of the MOSFET is connected to the sideways transformer thingy, T103. What's this all about?

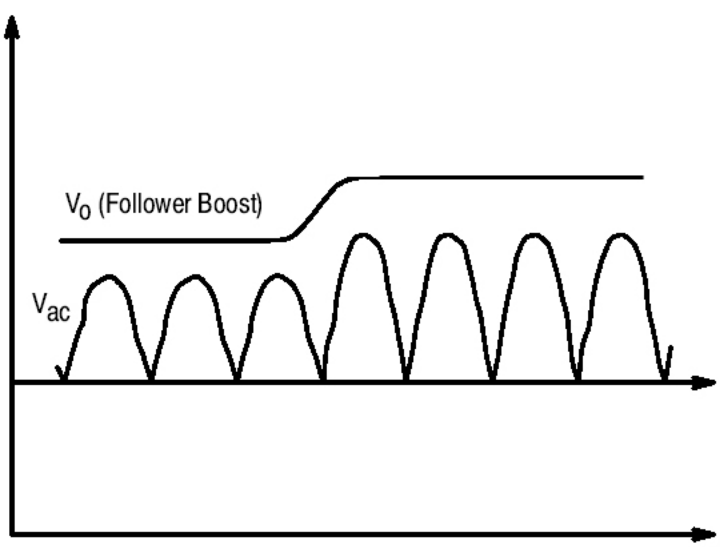
This, my friends, is a tricky little circuit called a "boost" power supply. In this case, it's more specifically called a "follower boost." The sideways transformer is, electrically speaking, just a coil. We're simply not using the secondary winding for anything. What we ARE using is the coil's ability to store energy, not as a charge (as we do with a capacitor) but in the form of a magnetic field.

Our goal here is to change the way the monitor's filter capacitor draws current from the bridge rectifier and, subsequently, the AC (mains). We're looking for a way to boost the pulsating DC output of the bridge rectifier so that instead of charging the filter capacitor with narrow, harmonic-producing spikes of current, we have a steady flow of current flowing from the bridge rectifier into the filter capacitor.

We accomplish this feat by pulsing MOSFET Q151. When Q151 is turned on, current will flow from the positive output of the bridge rectifier, through the coil in T103 and through Q151 to ground. The coil is our load and it builds up a nice big magnetic field. When Q151 is turned off, the magnetic field collapses. This



In the boost circuit, the pulses (the "on" time of the MOSFET) are of a fixed width. They come more rapidly when a large boost is needed and not at all when the AC sine wave is at its peak.



Follower Boost Characteristics

The "follower boost" circuit creates a voltage source that is added to the incoming AC voltage. If the incoming AC rises in voltage, the boost follows along, rising as well.

rapidly collapsing magnetic field slices across the coils of copper wire and turns the coil into an electric generator in a process called "induction." This newly generated voltage (you can kind of think of the coil as a battery for this moment in time) is now IN SERIES with the output of the bridge rectifier and, just like two or more dry cell batteries in series in a flashlight, the voltages are added together.

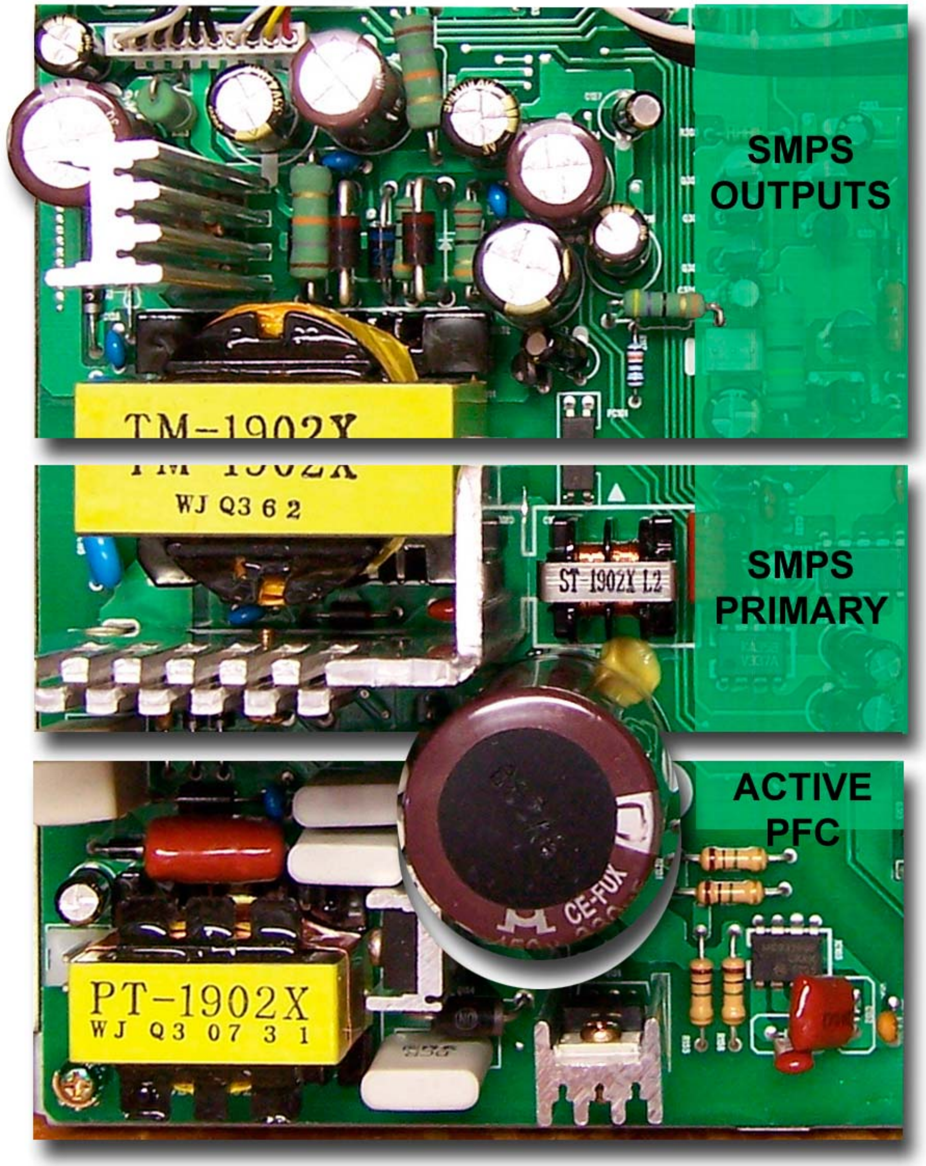
It's called a "follower boost" circuit because this newly generated voltage is added to the incoming voltage. If the incoming AC rises, the boost follows along, rising as well. We don't care about regulating the voltage at this point because we're going to do that next with the PWM part of the SMPS.

There is a notable difference between the way this circuit operates and the way the PWM controller works. PWM is just what it says; it is pulse-width modulation. The operating frequency remains constant while the duty-cycle of the pulse is shortened or lengthened in order to maintain a regulated output voltage.

In the boost circuit, the pulses (the "on" time of the MOSFET) are of a fixed width but they come more rapidly when a large boost is needed and not at all when the AC sine wave is at its peak.

The result is that we are taking a sine wave in and producing a constant voltage out and the upshot of this whole thing is that instead of charging the filter capacitor only during the brief peak period of the AC sine wave, we can keep a constant charge on it and substantially reduce (or eliminate altogether) the third-harmonic content of the system. This is known as "active power factor correction" or PFC.

The diodes we were talking about at the beginning of this discussion (D152 and D154) are a sort of electronic "anti-siphon" valve. They are used to ensure that the current doesn't "backflow" when, for example, the output voltage of the boost follower circuit is higher than the output voltage of the bridge rectifier.



The power supply can be divided into three sections: The active power factor correction, the SMPS primary and the SMPS outputs.

Other Things of Interest

Notice that IC105 gets its power (Vcc) from the 20 volt secondary of power transformer T101. The voltage is picked off at pin 4 of the transformer, rectified by di-

MC33260

GreenLine™ Compact Power Factor Controller: Innovative Circuit for Cost Effective Solutions

The MC33260 is a controller for Power Factor Correction preconverters meeting international standard requirements in electronic ballast and off−line power conversion applications. Designed to drive a free frequency discontinuous mode, it can also be synchronized and in any case, it features very effective protections that ensure a safe and reliable operation.

This circuit is also optimized to offer extremely compact and cost effective PFC solutions. While it requires a minimum number of external components, the MC33260 can control the follower boost operation that is an innovative mode allowing a drastic size reduction of both the inductor and the power switch. Ultimately, the solution system cost is significantly lowered.

Also able to function in a traditional way (constant output voltage regulation level), any intermediary solutions can be easily implemented. This flexibility makes it ideal to optimally cope with a wide range of applications.

General Features

- Standard Constant Output Voltage or “Follower Boost” Mode
- Switch Mode Operation: Voltage Mode
- Latching PWM for Cycle−by−Cycle On−Time Control
- Constant On−Time Operation That Saves the Use of an Extra Multiplier
- Totem Pole Output Gate Drive
- Undervoltage Lockout with Hysteresis
- Low Start−Up and Operating Current
- Improved Regulation Block Dynamic Behavior
- Synchronization Capability
- Internally Trimmed Reference Current Source
- Pb−Free Package May be Available. The G−Suffix Denotes a Pb−Free Lead Finish

Safety Features

- Overvoltage Protection: Output Overvoltage Detection
- Undervoltage Protection: Protection Against Open Loop
- Effective Zero Current Detection
- Accurate and Adjustable Maximum On−Time Limitation
- Overcurrent Protection
- ESD Protection on Each Pin

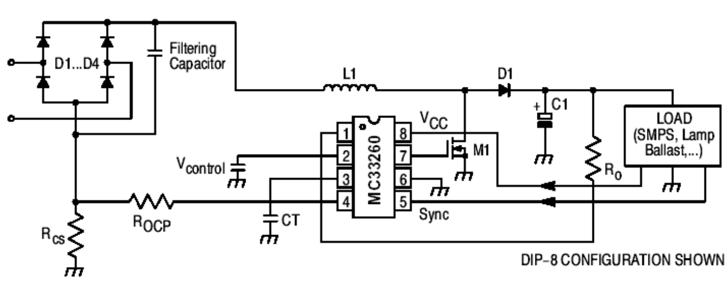


Figure 1. Typical Application

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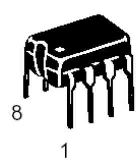
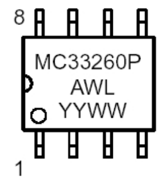
http://onsemi.com

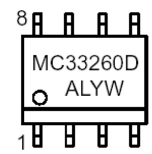
MARKING DIAGRAMS



DIP−8
P SUFFIX
CASE 626

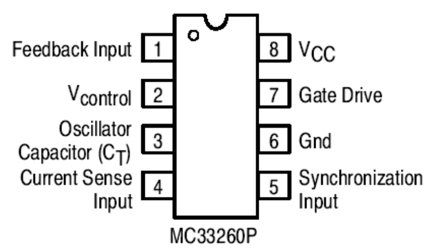


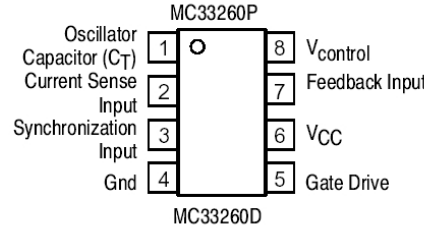
SO−8
D SUFFIX
CASE 751



A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

PIN CONNECTIONS





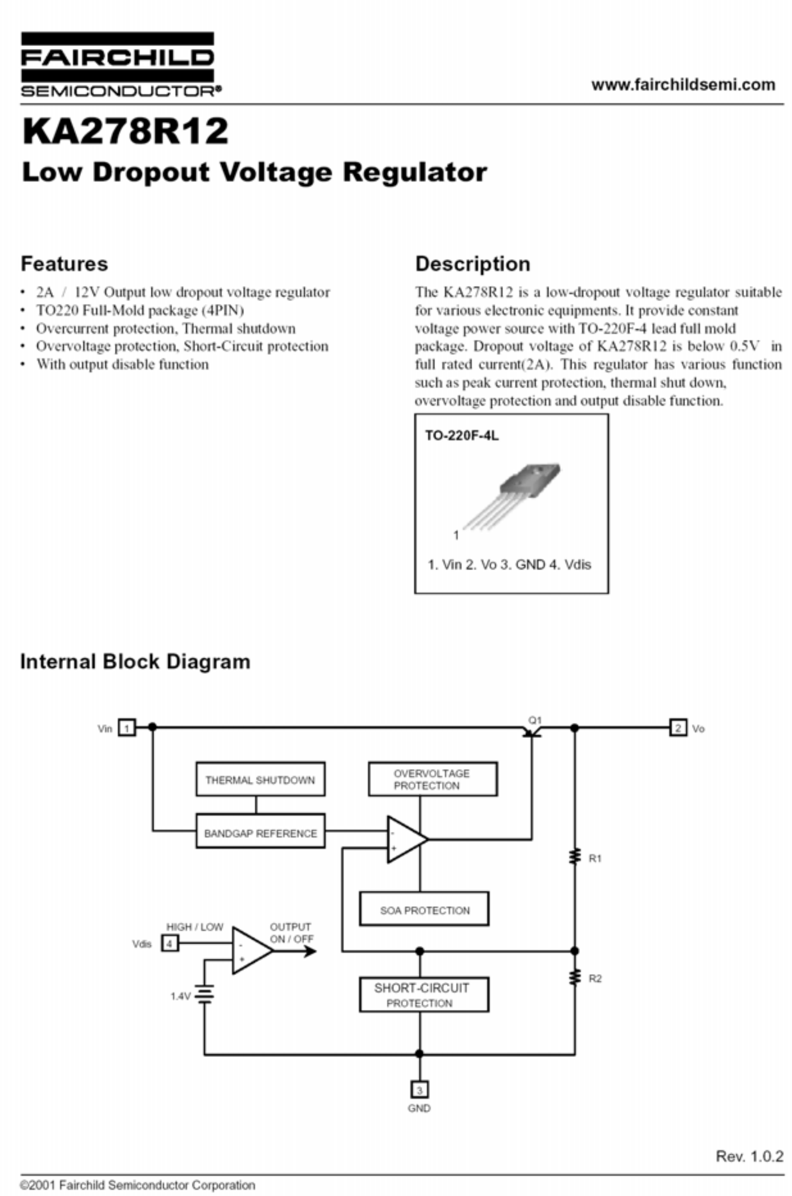
ORDERING INFORMATION

Device	Package	Shipping†
MC33260P	Plastic DIP−8	50 Units/Rail
MC33260D	SO−8	98 Units/Rail
MC33260DR2	SO−8	2500 Tape & Reel
MC33260DR2G	SO−8 (Pb−Free)	2500 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

ode D153 and filtered by electrolytic capacitor C154. This means that the follower boost circuit actually doesn't begin operating until the main SMPS is already up and running. We can see how the STR-F6656 gets its "kick start" from the raw DC, through resistor R103 and thereafter runs from the same 20 volt transformer secondary, this time rectified by diode D101 and filtered by capacitor C105.

I suppose my point here is that, if the PFC circuit were not operating at all, you likely wouldn't know it, as the unit would simply carry on as a regular SMPS. A much more likely failure scenario is that Q151 would short-circuit. This would blow the fuse. If the MOSFET inside the STR-F6656 blows, this would also blow the fuse. In either case, pay close attention to resistor R150, .47 ohm, 2 watts. It's in the negative return path of the bridge rectifier. If any sort of high-current weirdness happens on the primary side of the power supply, R150 might open-circuit. Likely electrolytic capacitor failures to look out for are probably C105 and C154. I am not saying that these capacitors (or anything else, for that matter) WILL fail. I am just saying that, in my experience with all types of monitors, these will be the likely weak points. I understand from my source within the company that Tovis has used especially high quality, low-esr, capacitors in these critical applications.


FAIRCHILD SEMICONDUCTOR®

www.fairchildsemi.com

KA278R12

Low Dropout Voltage Regulator

Features

- 2A / 12V Output low dropout voltage regulator
- TO220 Full-Mold package (4PIN)
- Overcurrent protection, Thermal shutdown
- Overvoltage protection, Short-Circuit protection
- With output disable function

Description

The KA278R12 is a low-dropout voltage regulator suitable for various electronic equipments. It provide constant voltage power source with TO-220F-4 lead full mold package. Dropout voltage of KA278R12 is below 0.5V in full rated current(2A). This regulator has various function such as peak current protection, thermal shut down, overvoltage protection and output disable function.

TO-220F-4L

1. Vin 2. Vo 3. GND 4. Vdis

Internal Block Diagram

Rev. 1.0.2

©2001 Fairchild Semiconductor Corporation

The output side of the power supply is all completely standard with the exception of the A278R12 voltage regulator. This is a nifty little voltage regulator, used for the +12 VDC output. It's not so much that we really needed another regulator here - after all, the SMPS itself can provide us with a nice, regulated +12 VDC output. The A278R12 is cool because it has a "disable" input and can be turned on or off with an external signal from the monitor's processor. In this case, the signal is called "suspend." If the "suspend" signal is high, the regulator is turned on. If the "suspend" signal is low, the +12 VDC output is turned off. Since the +12 VDC is used to power things like the IC that controls the high voltage (we'll look at this in detail in a subsequent issue) killing the +12 VDC output is a handy way to handle things like EHT shutdown.

- Slot Tech Magazine

SENCORE® tech tips

Means Success In Electronic Servicing

Testing Microprocessors with the SC61 Waveform Analyzer™

Many technicians think that microprocessors are difficult to service. Why? Probably because they think of microprocessors as computers. Yet, most microprocessor systems are used as controllers, not computers. Examples of controllers are found in VCRs, microwave ovens, TV receivers, and most microprocessor-controlled test equipment. Knowing this can make servicing microprocessors a lot less fearful.

Let's start with a practical piece of advice: don't change the microprocessor too quickly. Time and time again, technicians admit that changing a microprocessor doesn't help a problem which looks like it *might be* caused by a bad micro. But, microprocessors rarely fail. They are protected from static discharge and power line surges by filtered power supplies and by buffering transistors and ICs. The best process is to leave it on your list of suspects, but be sure to interrogate all the other likely culprits first.

You can quickly isolate most microprocessor-related problems, using the Sencore SC61 Waveform Analyzer and five quick tests we will cover a little later. First, let's see how a micro-processor used as a controller differs from one used as a computer, so that you can see why "microprocessor servicing" has very little to do with "computer servicing".

The Computer vs the Controller

The biggest difference between a microprocessor used in a computer and one used as a controller has to do with programming. A *computer* can be reprogrammed as needed, usually by entering information from a magnetic disk or tape. The *controller* lives a relatively boring life - playing the same program over and over. Reprogramming rarely happens once the system has left the factory. This main difference leads to several other differences as well.

Computers (whether desk-top personals or large mainframes) handle large volumes of assorted data. One batch may be numbers for a payroll, and the next may be a document from a word processor. *Controllers,* by comparison, deal with much smaller volumes of data. The data are repetitive and predictable, often representing inputs from simple switches and sensors within the system.

The microprocessor used in a *computer* connects to thousands or millions of bytes of external random-access-memory (RAM), each byte containing 8 memory locations. This RAM may require dozens of external memory chips. The microprocessor used as a controller only needs a small amount of memory – often inside the microprocessor chip itself.

Lastly, a computer has complex inputs and outputs. Inputs come from typewriter keyboards, disk drives, or modems. Outputs feed printers, plotters, CRT displays, or other computers. The controller only has inputs from a few ICs, relays, and a simple digital display.

Servicing controller-type microprocessors doesn't need to be any more complicated than servicing any integrated circuit. The limited environment of the controller means you don't have to know many things you might think you need to know.

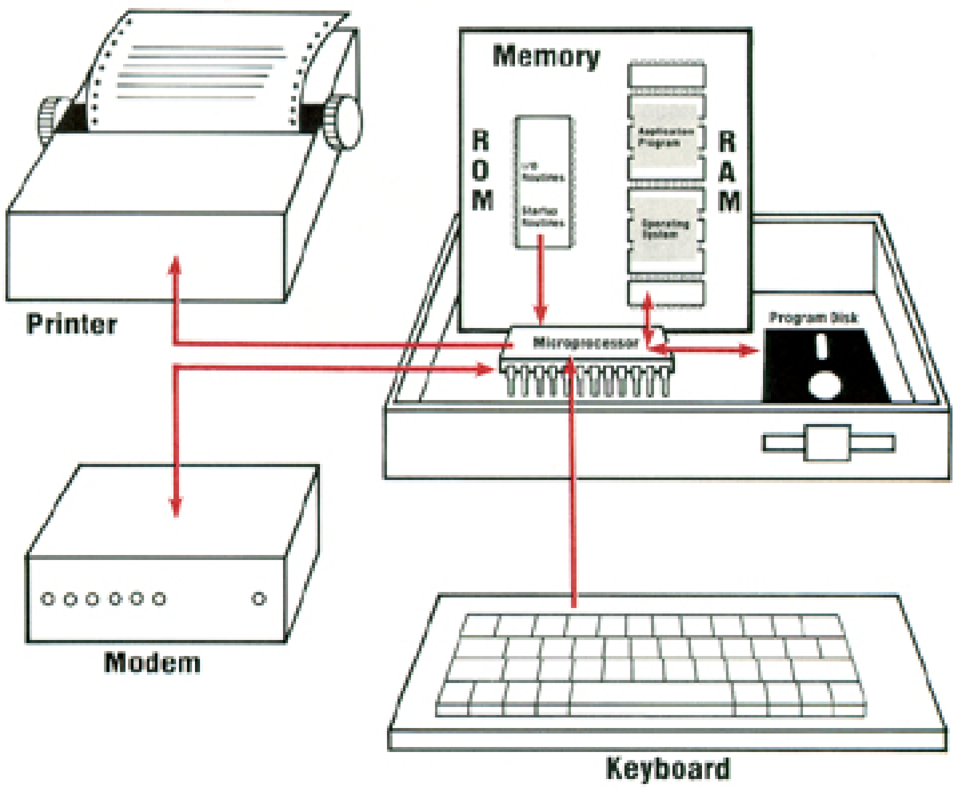


Fig. 1: The main thing that sets a computer apart from a controller is that the computer gets new programs from a disk or tape. It also has external memory, and complex inputs and outputs.

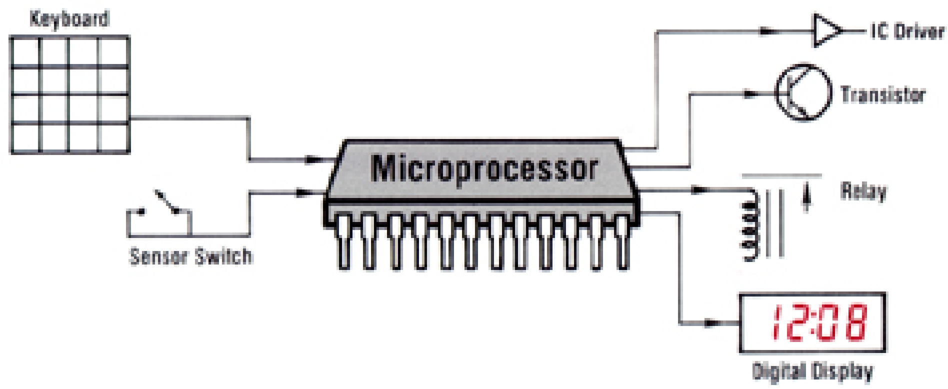


Fig. 2: The microprocessor used as a controller is programmed one time at the factory. It uses simple switches and sensors for inputs, and transistors, ICs, relays, and digital displays for outputs.

The Simplified System

One of the biggest differences between servicing computers and controllers is that you don't have to worry about software problems in controllers. You don't need to know programming or ASCII codes. If you suspect a software problem, you have only one option; change the program chip.

Second, you don't have to sort through rows and rows of memory chips. This means you don't need a $20,000 logic analyzer or an 8-channel scope to view each byte of data separated in order to locate a defective memory location. If an internal memory location is bad, you have to change the microprocessor.

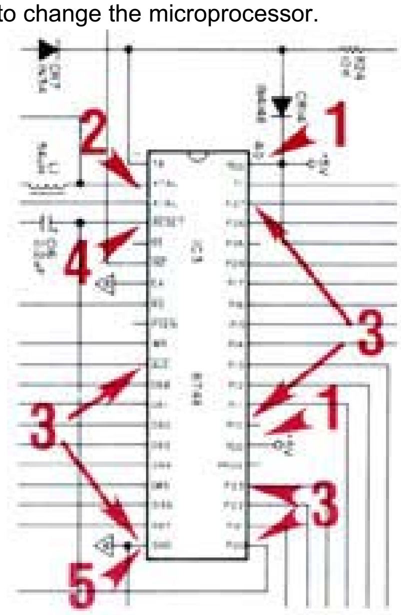


Fig. 3: Most defects are caused by problems outside the microprocessor. Test the microprocessor inputs and outputs in this sequence to isolate external problems before substituting with a new one.

Finally, the controller has limited inputs and outputs – generally no more than 8 of each. You can test each one separately to confirm whether the problem is coming from inside the microprocessor or from an external component.

Once you stop worrying about software, memory, and complicated interface systems, the microprocessor takes on a whole new look. You can find most problems with five standard tests using the Sencore SC61 Waveform Analyzer. The tests are of: 1. The power supply, 2. The clock, 3. The input and output lines, 4. The reset circuit, and 5. The grounds. Here's how to do these tests with the SC61.

1. Test the Power Supply

Always test the power supply(s) first, whether the problem is a totally dead micro or one with erratic operation. Start with the DC level. Press the channel A Digital Readout "DCV" button, so that you can monitor the DC level, while you watch for AC problems on the CRT.

Touch the channel A probe to the power supply pin. Glance up at the digital display to confirm the DC voltage (usually 5 to 10 volts) is correct. Your voltage should be within about 0.2 volts of the correct level.

But, don't stop there, because noise often enters the microprocessor through the power supply, causing it to act erratically. Look at the CRT to confirm the signal is clean. Press the "PPV" button to measure its actual value. You should see less than 0.1 volts of ripple.

You may see 60 Hz ripple from a bad filter or regulator. Or you may see high frequency digital noise from another stage, which can cause the micro to freeze as the noise pulses intermix with normal input signals. If so, suspect a bad filter or decoupling capacitor on the power supply line, or a bad IC on the same line which is loading the supply.

If the microprocessor has more than one power supply pin, check each one in the same manner.

Fig. 4: When testing the power supplies, use the DCV function to confirm correct regulation and the CRT to find noise or ripple.

2. Test the Clock

A problem in the crystal-controlled clock can cause intermittent operation. Watch for the following conditions as you probe one, then the other of the microprocessor pins connected to the clock input pins, usually coming from a crystal.

First, reach over and press the "FREQ" button. The SC61's autoranged frequency function displays the operating frequency with six full digits of resolution, so that you can be sure of the results. If the frequency is wrong, suspect a bad crystal.

Next, press the "PPV" button, and look up at the digital readout to confirm the signal has the correct amplitude. Although the crystal might be putting out the correct frequency, the micro may not know it, because the amplitude is just below the point that gives reliable operation.

Lastly, check the CRT waveform to make certain the clock does not include extra "glitch" signals. These extra signals may cause the microprocessor to intermittently skip a program step, or may cause the whole system to run too fast. The clock should be a clean sine or square wave.

Fig. 5: Test the clock for correct frequency, amplitude, and cleanliness. A glitch riding on the signal, as shown here, can cause the microprocessor to act like it is defective.

3. Test the Input and Output Lines

Inputs: Generally, input defects affect only a few functions. Try every function controlled by the micro and note which ones work correctly and which ones have troubles. Then, determine which input pins are associated with the bad functions. For example, one or two switches might provide an input to a single function and not be used with any other of the micro's inputs.

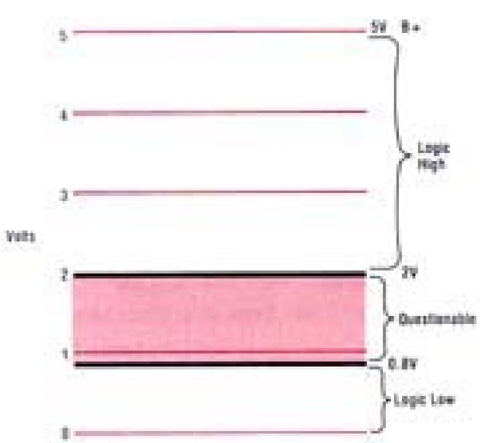


Fig. 6: Use the SC61 CRT to confirm that the signals have enough peck-to-peak swing to keep them out of the questionable area, shaded in red.

Connect your SC61 probe to the pins associated with the questionable functions and observe the trace as you cycle the input switches. Press the "DCV" button, and note the DC level with the switch contact open and with it closed to be sure the level properly changes between the "one" and the "zero" logic level. Be sure that neither level falls into the "undefined" area between the two levels, or the micro may not be able to decide whether a high or a low condition exists.

Check contact resistance or pull-up resistors if the levels are wrong. Watch for noise or glitches which may cause the micro to interpret a single switch operation as two or more separate switch closures. Check the switch contacts, de-coupling capacitors, and switch buffer circuits to isolate noise conditions.

Outputs: Next, test all data (output) lines to be sure one isn't stuck at logic high or logic low. Touch your probe to each microprocessor output pin, one at a time. Don't worry that the signal shows a blur of lines – seemingly out of sync. This is simply because of the asynchronous (random) data coming from the micro.

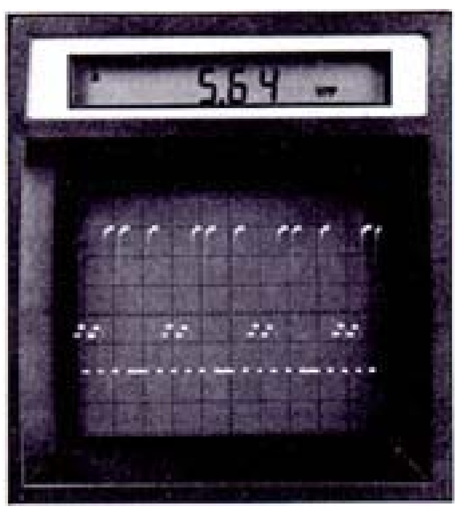


Fig. 7: The data at each pin will appear to be out of sync because it is constantly changing. Concentrate on the fact that each pin is toggling, and not stuck at logic high or low.

Set the SC61's CRT to its "DC-coupled" mode to confirm that the low points on the waveform are below the minimum level for a "zero" and that the high points are above the minimum level for a "one". Suspect a bad pull-up resistor or IC outside the micro if the signals are falling between logic levels.

If the signal at a pin remains cemented to ground or to B+, look at the schematic to see when that pin is used. You might have to trace the pin to a relay or an IC to find out which function(s) it controls. Then, force the microprocessor into a function which uses this pin by pressing a button or cycling a sensor.

If the signal at the pin doesn't change, isolate the pin from the external circuits by carefully removing the solder between it and the foils on the P.C. board. Connect your SC61 to the isolated pin and again check for toggling. If the pin toggles with its load removed, the problem is most probably outside the micro. An external component is holding the pin high or low. Isolate each component on that line, one at a time, until the line toggles. Then, replace the defective part.

If the pin remains stuck after being isolated, it's beginning to look more like a defective microprocessor, but don't unsolder the other legs yet. You've got two more checks to make.

4. Test the Reset Circuit

Microprocessors need an external reset pulse at turn-on. Without the reset pulse, the microprocessor starts in the middle of the program resulting in totally unpredictable operation.

Take advantage of the SC61's CRT to check the reset pulse. Set the Trigger "Source" switch to channel A, the Trigger "Mode" switch to "Norm" and the Trigger "Level" control to the zero in the center of its rotation.

Connect the device containing the micro-processor to a switched AC outlet strip, so that you can turn the power off and on. Don't rely on the device's power switch, since the microprocessor often receives power independent of the power switch. In fact, many "power" switches are simply one of the microprocessor inputs, and don't interrupt power.

Turn off the power and connect the SC61 channel A probe to the reset pin. The SC61 CRT should show no trace. Watch the CRT as you apply power to the system. If you see the trace flash across the CRT, you know a reset pulse occurred and triggered the SC61 sync circuits. If there is no trace, repair the reset circuits.

5. Check Grounds

Now, the microprocessor is highly suspect. But, don't unsolder it yet. First, check every grounded pin. Each should show *zero volts DC and zero volts AC*. If

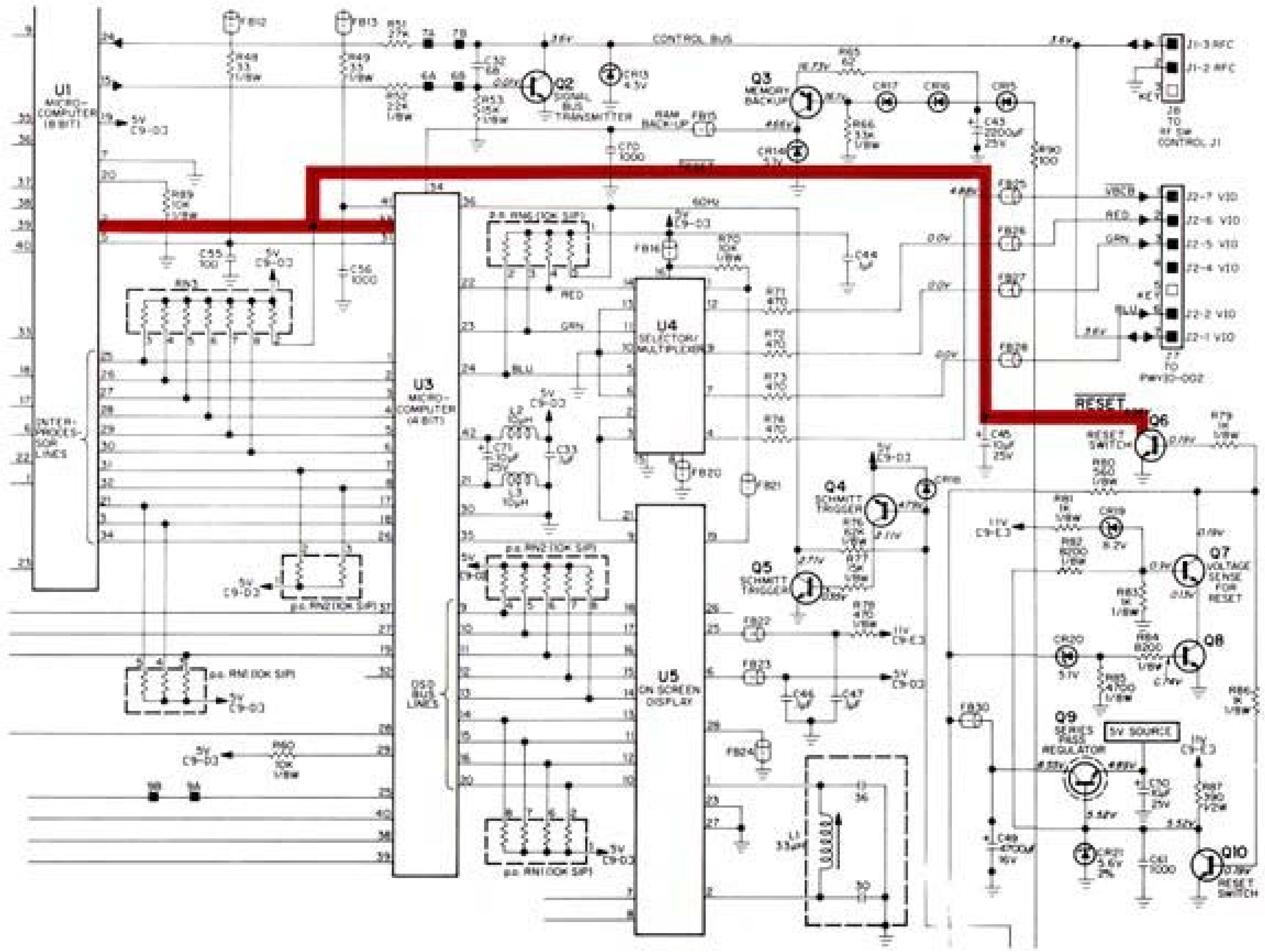


Fig. 8: Watch for a reset pulse when you first apply power. Defective reset circuits make the microprocessor appear defective, because it did not start at the beginning of the program.

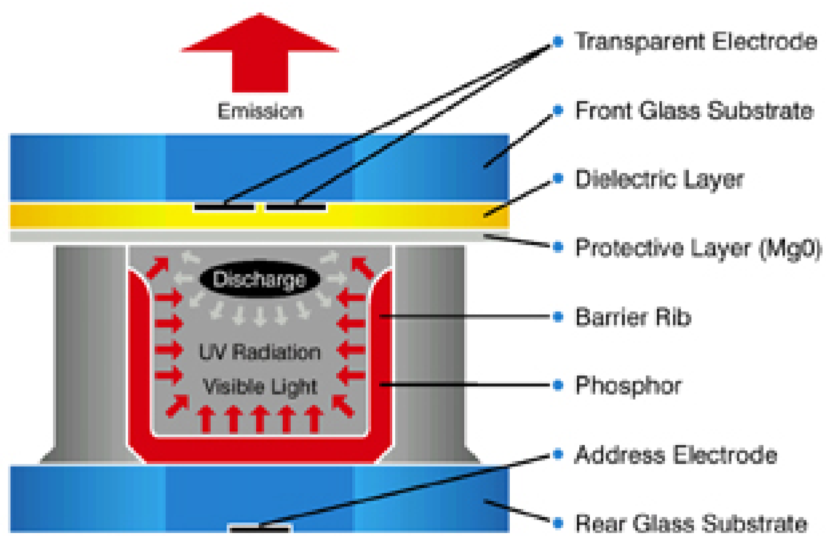
any grounded pin has a signal on it, it will cause the microprocessor to act as though the micro itself is bad. The presence of a signal tells you there is an open in the grounded path – either a broken P.C. foil or a bad solder connection. Repairing the bad ground will probably clear up your troubles.

If the grounds are good, you are ready to substitute the micro. You've already confirmed that all the inputs and outputs are normal. And, as we mentioned earlier, one of these other circuits will *usually* be the cause of the poor operation.

Plasma Display White Balance Calibration

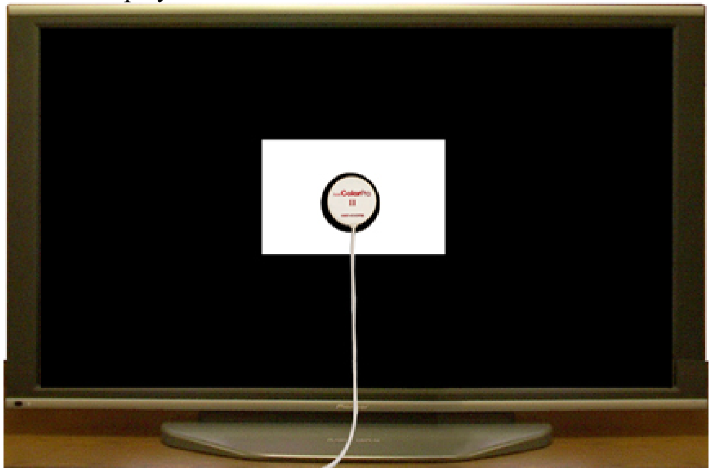
Calibrating the white balance of a plasma display is very much like calibrating a CRT display. Even though a plasma panel does not have three separate electron "guns," and doesn't have electrons striking phosphors, the calibration procedure is still set up to be pretty much the same.

A plasma display actually has the same type of red, green and blue phosphors as a CRT. The big difference is that the plasma display uses an inert gas discharge cell, containing each phosphor dot, to generate ultraviolet radiation that excites the phosphor, instead of a stream of electrons from a heated cathode (the term plasma simply means a partially ionized gas). When a high voltage is applied to the inert gas, it ionizes (like in a fluorescent bulb), producing UV radiation. This radiation strikes the adjacent phosphor, causing it to produce light.



Courtesy Pioneer

The light output produced by the plasma-excited red, green, and blue phosphors still needs to be balanced to the desired color of white light at both high light and low light levels. This leads to a set of controls on the display for low light balance that is still usually called cutoff or bias and a set of controls for high light balance that is still usually called drive or gain (Pioneer calls them simply the high light and low light adjustments).

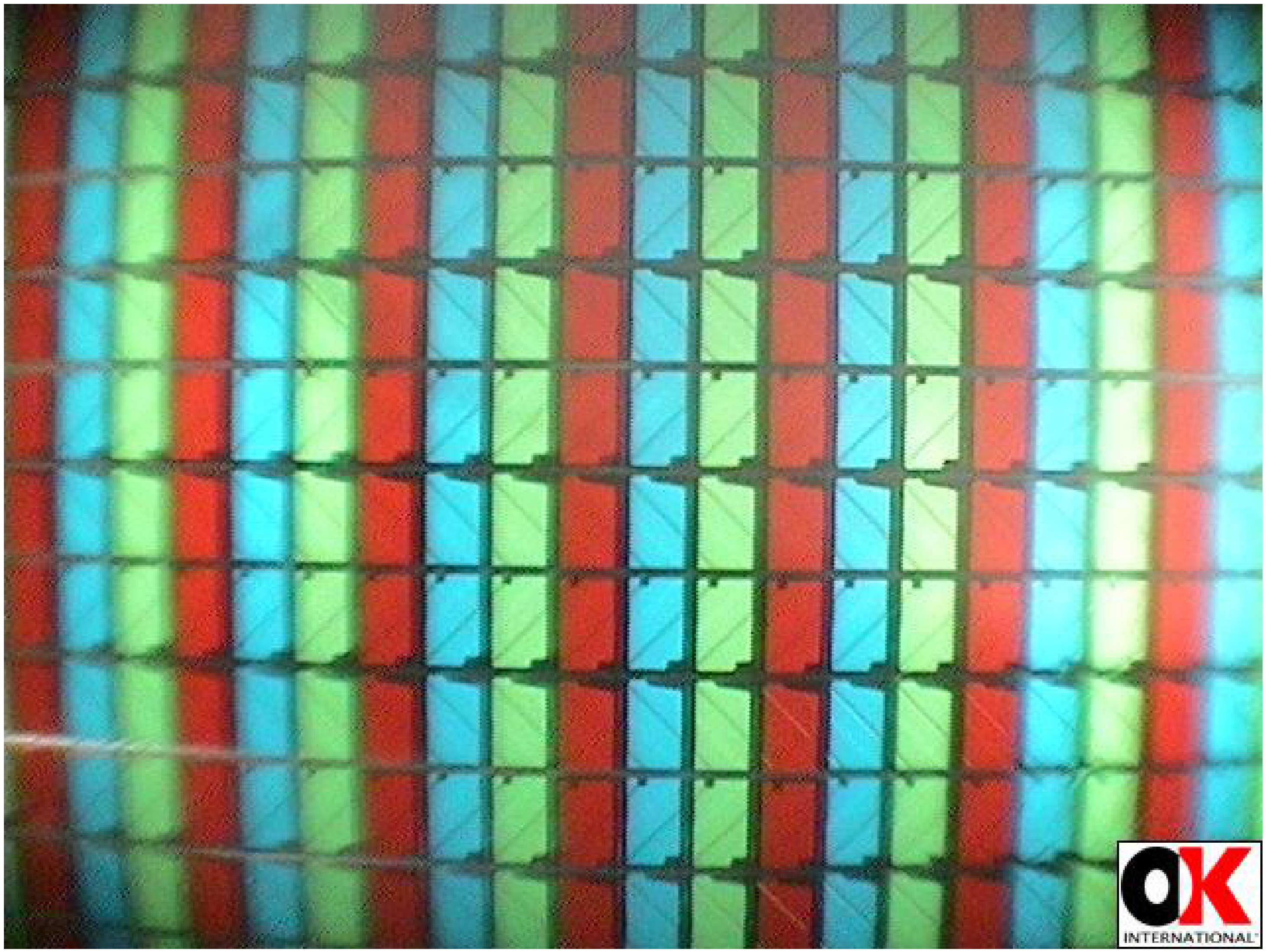


A white window pattern at high luminance and at low luminance (typically 100 IRE and 20 IRE) is used as the reference signal and a color analyzer is used to check whether the light output is balanced to the desired color (CIE D65) at both high and low light levels.

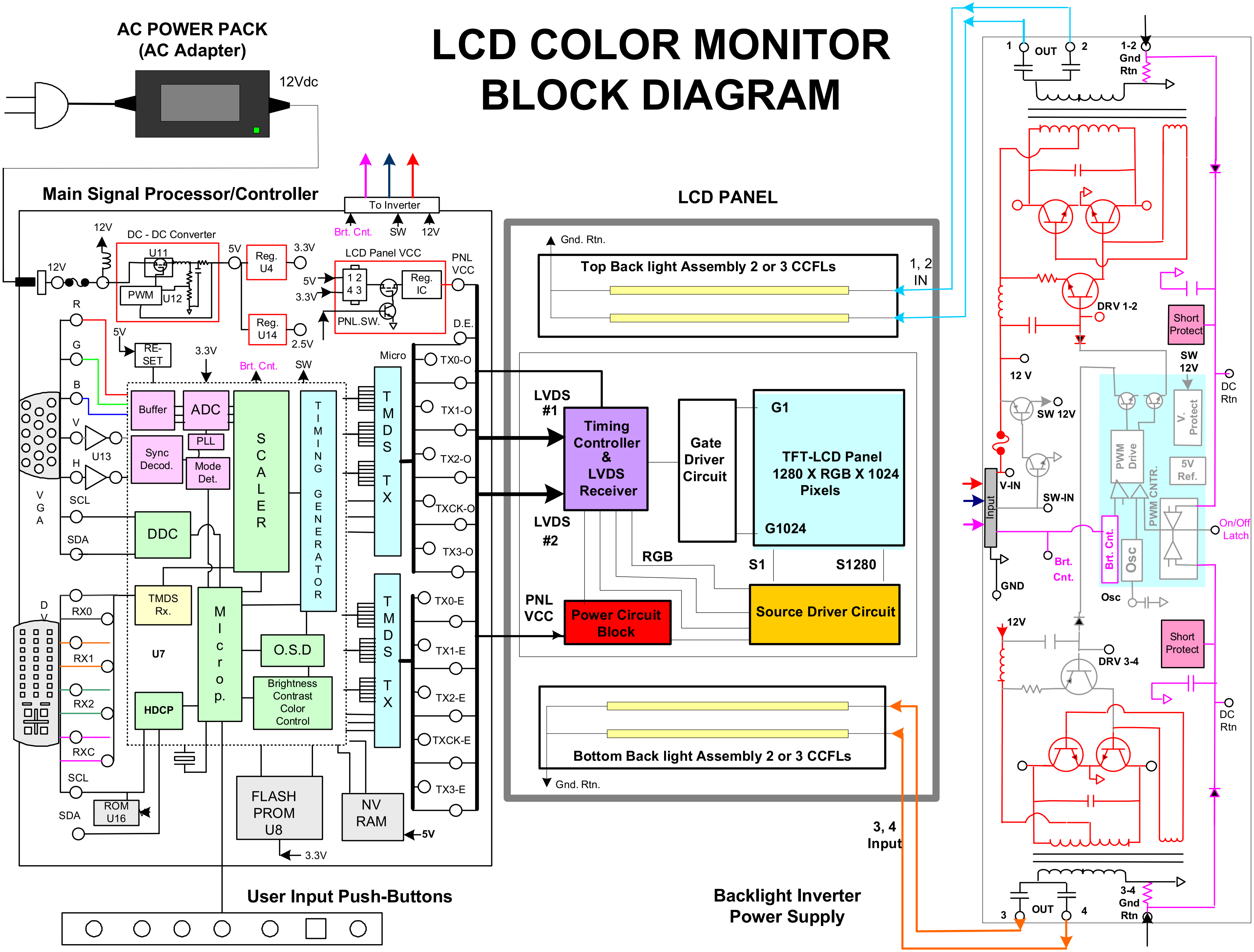
Even though plasma display technology is quite a bit different than CRT technology, you are still simply balancing the light produced by red, green, and blue phosphors to produce the industry-standard D65 white light. Since this is the white reference used to produce all video programming, all colors will be more accurate when shown on a display white balanced to D65. Because of this, the VP300 VideoPro and the CP288 or CP291 ColorPro are an ideal pair of instruments to use when calibrating plasma displays and others to produce the absolute best quality pictures they are capable of displaying.

Actual LCD RGB Pixel shot with electron microscope

Black shadow area in each pixel
is a TFT (thin film transistor)

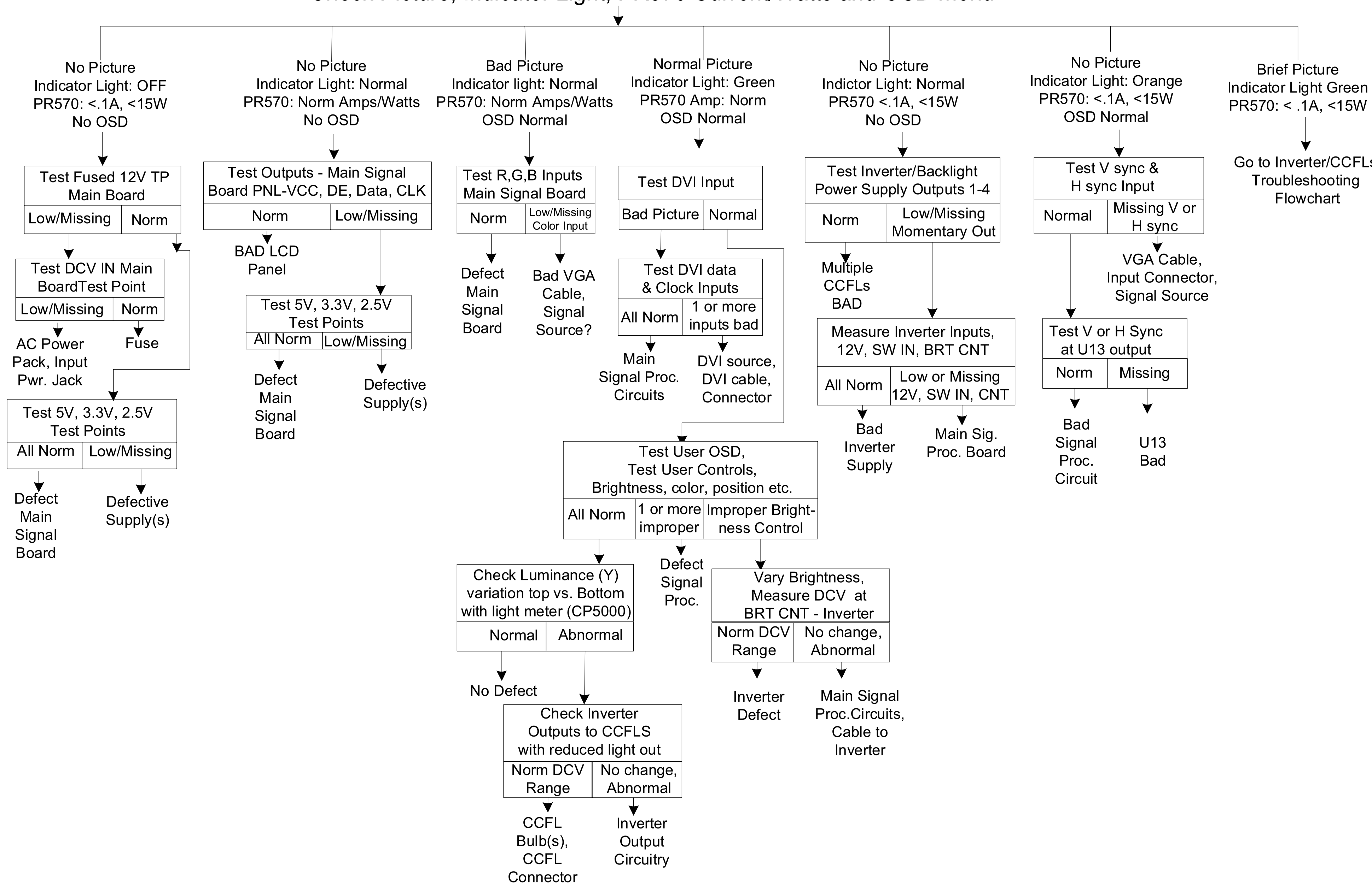


LCD COLOR MONITOR BLOCK DIAGRAM



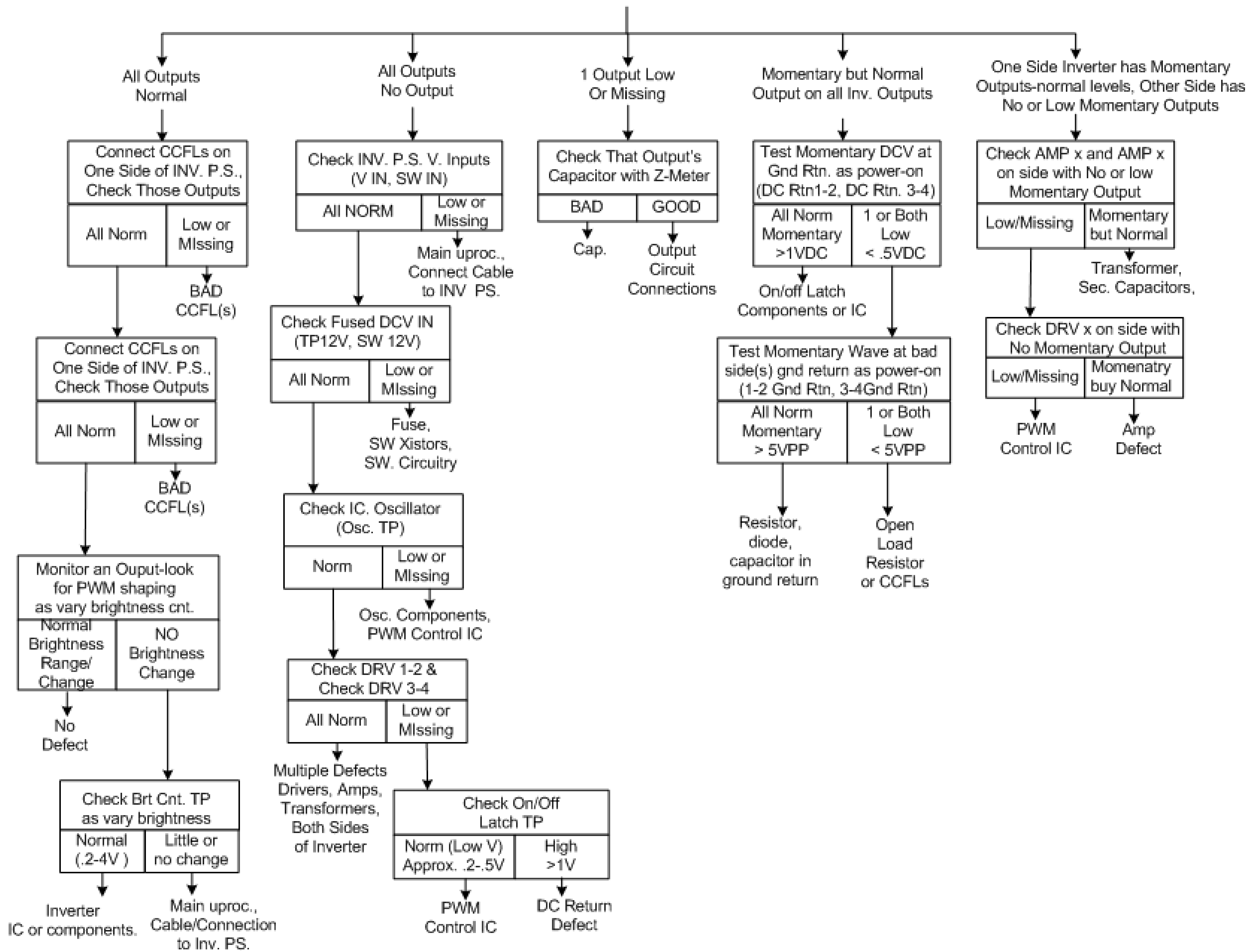
LCD Monitor Troubleshooting Flow Chart

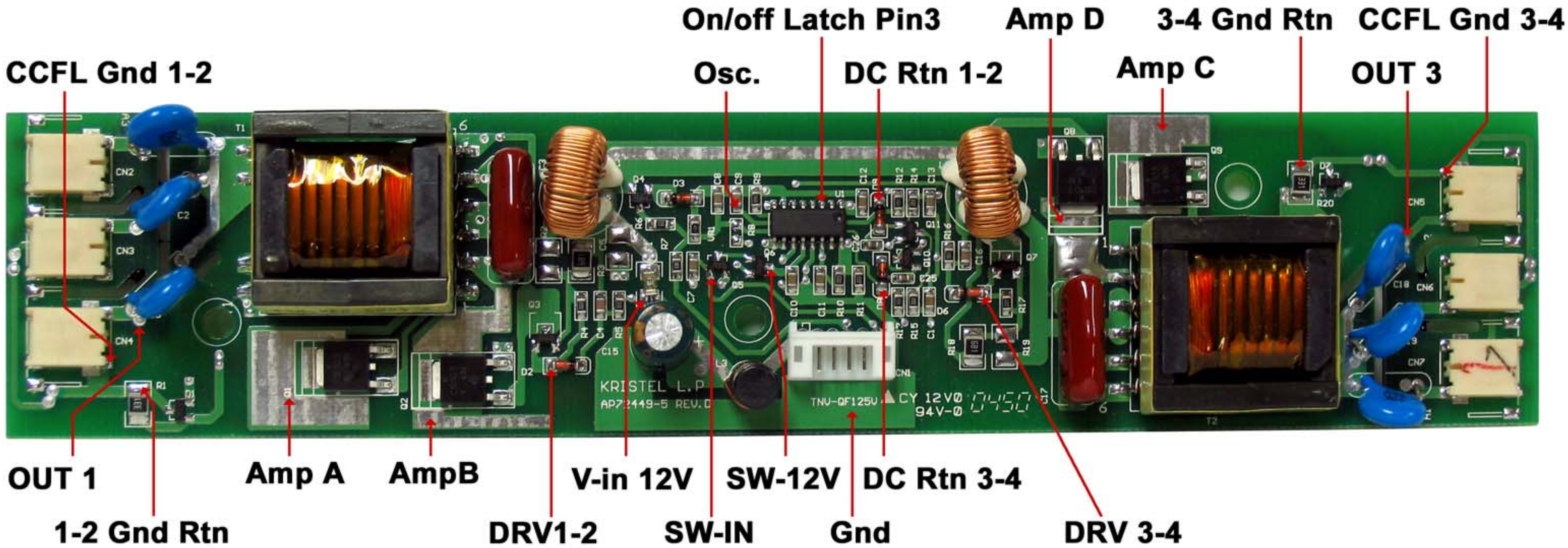
Input Test Signal to VGA Input - Use native resolution SXGA 1280X1024 60Hz
Apply 12V Input (Connect AC Power Pack to PR570),
Check Picture, Indicator Light, PR570 Current/Watts and OSD menu



BACKLIGHT INVERTER POWER SUPPLY TROUBLESHOOTING FLOWCHART

APPLY RESISTOR DUMMY LOAD (150k) TO EACH SIDE OF INVERTER P.S.,
Apply Power to LCD Monitor or To Inverter P.S. - Test Each CCFL Output with SC3100
Test Sequence: Power OFF - Connect SC3100 (OUT x/Gnd) - Power ON - Measure - Power OFF - Repeat





CCFL Gnd 1-2
OUT 1
1-2 Gnd Rtn
Amp A
AmpB
DRV1-2
V-in 12V
SW-IN
Osc.
On/off Latch Pin3
SW-12V
Gnd
DC Rtn 1-2
DC Rtn 3-4
DRV 3-4
Amp D
Amp C
3-4 Gnd Rtn
CCFL Gnd 3-4
OUT 3
KRISTEL L.P
AP72449-5 REV.0
TNV-QF125V CY 12V0
94V-0

Activity: A Real Backlight Inverter Power Supply Familiarization

Objective:

1. **Become familiar working with a Real Backlight Inverter Power Supply.**
2. **To become familiar with voltages, waveforms and key test points in a real backlight inverter power supply.**

Setup. Using the PS400 Power supply:

1. Set the Voltage to 12 volts.
2. Set the Current control to Max.
3. **Turn off the PS400 Power at this point.**
4. Plug the Connector into the LCD Inverter and connect it to the PS400 with the red lead of the PS400 to the positive and the black lead to the ground lead of the connector.
5. Hook up the leads of the Load Blocks to the OUTPUTS of the Inverter before turning on the power.
6. Turn on the power for the PS400.

Procedure: With the scope ground hooked to the ground connection on the Inverter, begin to take and record your measurements and waveforms for the following test points.
Note of Caution: **Be VERY careful when touching test points and also when working by and around the transformers and outputs of the inverter. The output is a very high voltage (<2kV).**

Test Point	DCV	VPP	Frequency	Waveform
V IN	_______			
12V	_______			
SW-IN	_______			
SW-12V	_______			
Osc	_______	________	__________	__________________
DRV1-2	_______	________	__________	__________________
DRV3-4	_______	________	__________	__________________
Amp A	_______	________	__________	__________________
Amp B	_______	________	__________	__________________
Amp C	_______	________	__________	__________________
Amp D	_______	________	__________	__________________

Measurements Continued:

Test Point	DCV	VPP	Frequency	Waveform
1-2 Gnd Rtn	______	______	______	______
3-4 Gnd Rtn	______	______	______	______
DC RTN 1-2	______			
DC RTN 3-4	______			
On/off Latch	______			

Procedure: To measure OUT 1 across CCFL Load Box, remove DC Power from the Inverter. Connect the Scope Ground to the CCFL Ground on the CCFL Jack and the Probe lead to the Output. Then apply DC voltage to the Inverter and record the measurements. Repeat this procedure for Out 3.

Test Point	VDC	VPP	VRMS	Frequency	Waveform
OUT 1	______	______	______	______	______
OUT 3	______	______	______	______	______

(Other OUTs are identical)

Make sure choosing your Gaming Monitor cables isn't a 'crap shoot'!

Sencore is now offering specialty cables to interface test signals from a Sencore model video generator to popular gaming monitors. Get a **FREE** updated **Gaming Monitor Schematic CD** (includes LCD monitors) with the purchase of gaming monitor cables.

SENCORE Gaming Monitor Test Cables

***All cables work with Sencore Generators: CM125, CM2125, and VP40x**

Monitor Connection Cable	Sencore Part #	Price
Ceronix 6 pin molex	39B798-C6	$49.95
Ceronix 7 pin molex	39B798-C7	$49.95
Tatung 9 pin molex	39B798-T	$49.95
Wells Gardner 10 pin molex	39B798-W	$49.95
Kristel 24 pin molex	39B1130	$59.95
Tovis or Kortek 25 pin metrimate	39B1131	$59.95
Kristel 25 pin metrimate	39B1132	$59.95
Kortek 19 pin metrimate	39B1133	$59.95

More SENCORE Gaming Monitor Test Cables

Monitor Connection Cable	**Sencore Part Number**
Adapter #4 — Adapts CM2125 output to gaming monitor test cables.	39B274
Universal AC Cord Kit — Connects AC voltage to various sized male connector pins found in molex, metrimate and other connectors.	39G785
HD 15pin VGA male to VGA male - 6 ft. cable — Connects CM2125's 39B274 adapter output or the VP40x output to gaming monitors (including most LCD monitors) with a standard VGA input connector.	39B798
DVI to VGA Adapter — Adapts VP40x output to gaming monitor test cables.	39G1061

That's a quick rundown of some of the new cables we have available from Sencore. If you would like additional information on these or any other product from Sencore, simply give us a call (**1-800-SENCORE, 736-2673**) or go to our website www.sencore.com, or drop us a quick email sales@sencore.com and we will be glad to get the information on its way to you.

P.S. Don't forget to ask about a **FREE Gaming Monitor Schematic CD** with your purchase of gaming cables.

Thank you,

Don Multerer

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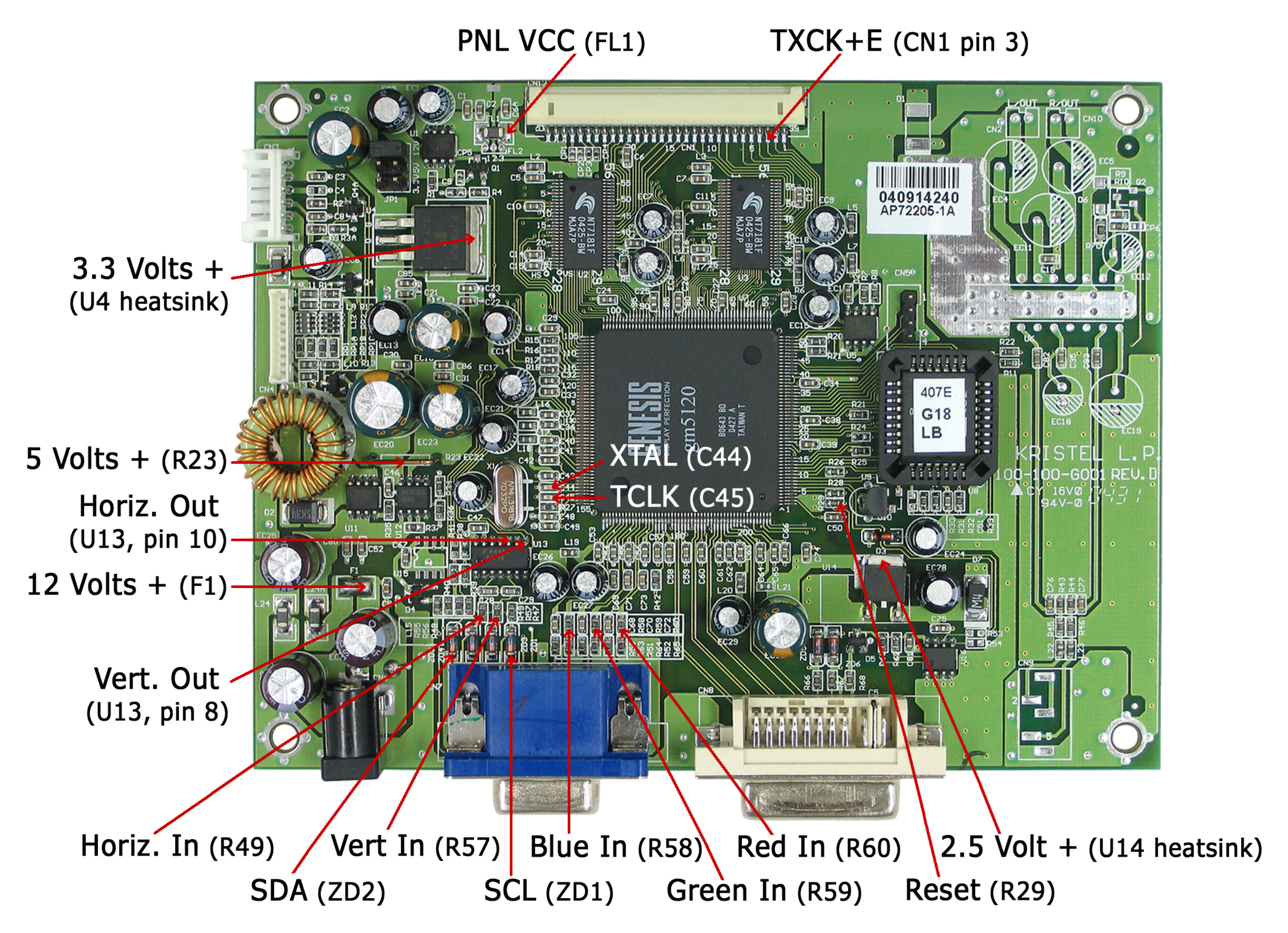

PNL VCC (FL1)
TXCK+E (CN1 pin 3)
3.3 Volts + (U4 heatsink)
5 Volts + (R23)
Horiz. Out (U13, pin 10)
12 Volts + (F1)
Vert. Out (U13, pin 8)
XTAL (C44)
TCLK (C45)
Horiz. In (R49)
SDA (ZD2)
Vert In (R57)
SCL (ZD1)
Blue In (R58)
Green In (R59)
Red In (R60)
Reset (R29)
2.5 Volt + (U14 heatsink)