Welcome

Amusement & Music Operators Association

LCD Monitor Power Supply Troubleshooting Seminar Part #2

***INSTRUCTOR: Ray Holdren**,*

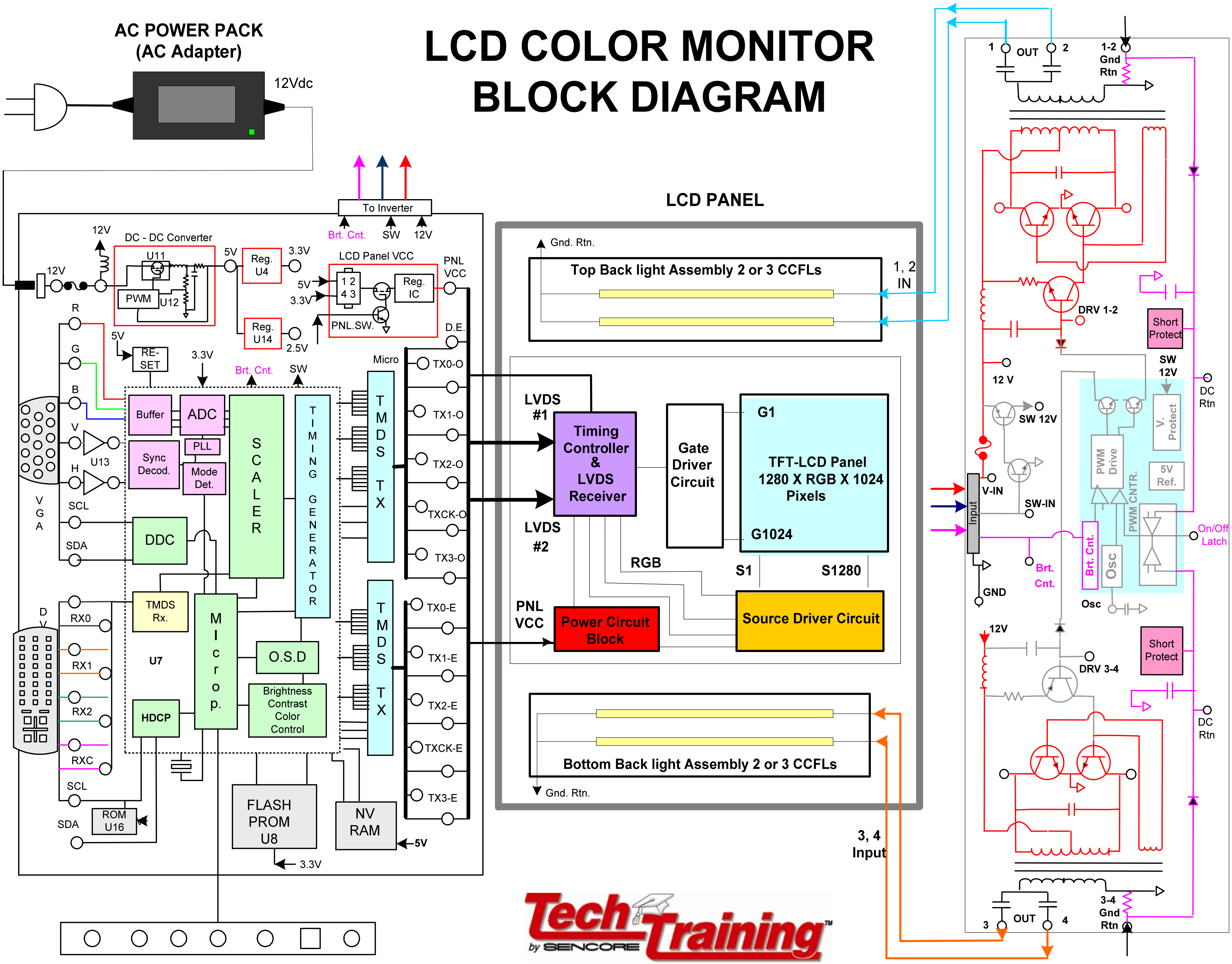
Kokopelli Consulting, Las Vegas

Instructor for *CSN's Workforce Development Program*

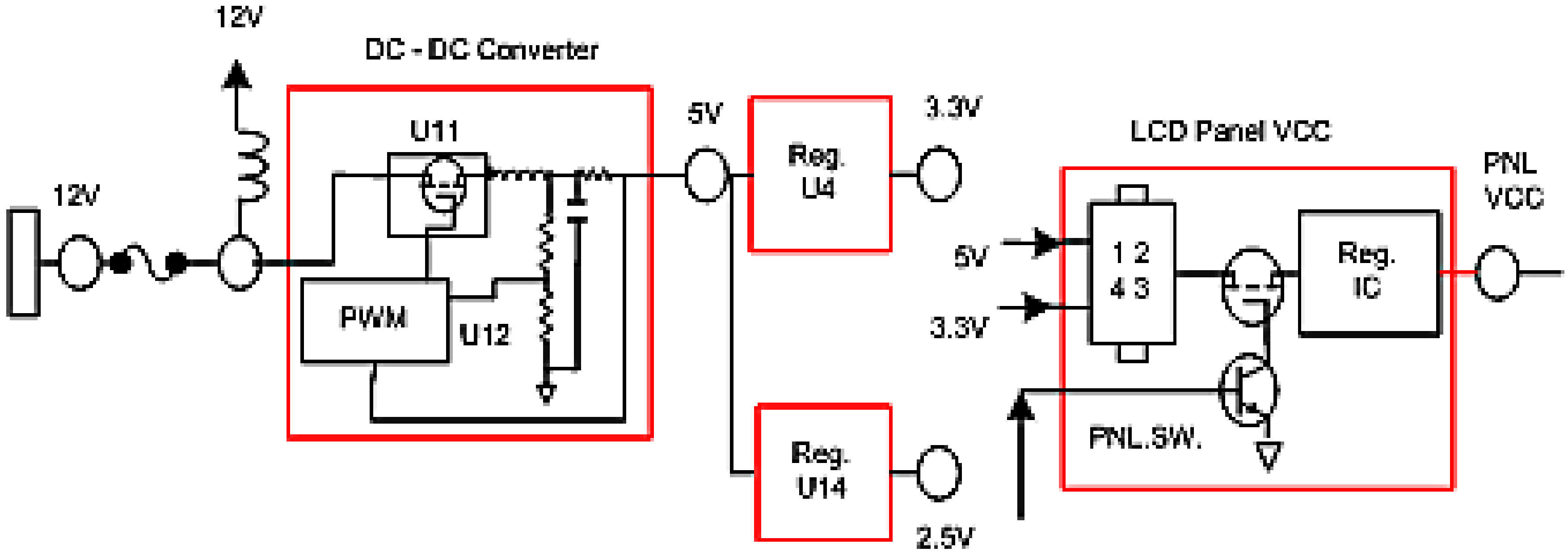
Teacher for the *College of Southern Nevada*, Cheyenne Campus, *North Las Vegas*, *NV*

Ray.Holdren@csn.edu

LCD COLOR MONITOR BLOCK DIAGRAM



Main Signal Processing/Controller Board Power Supplies



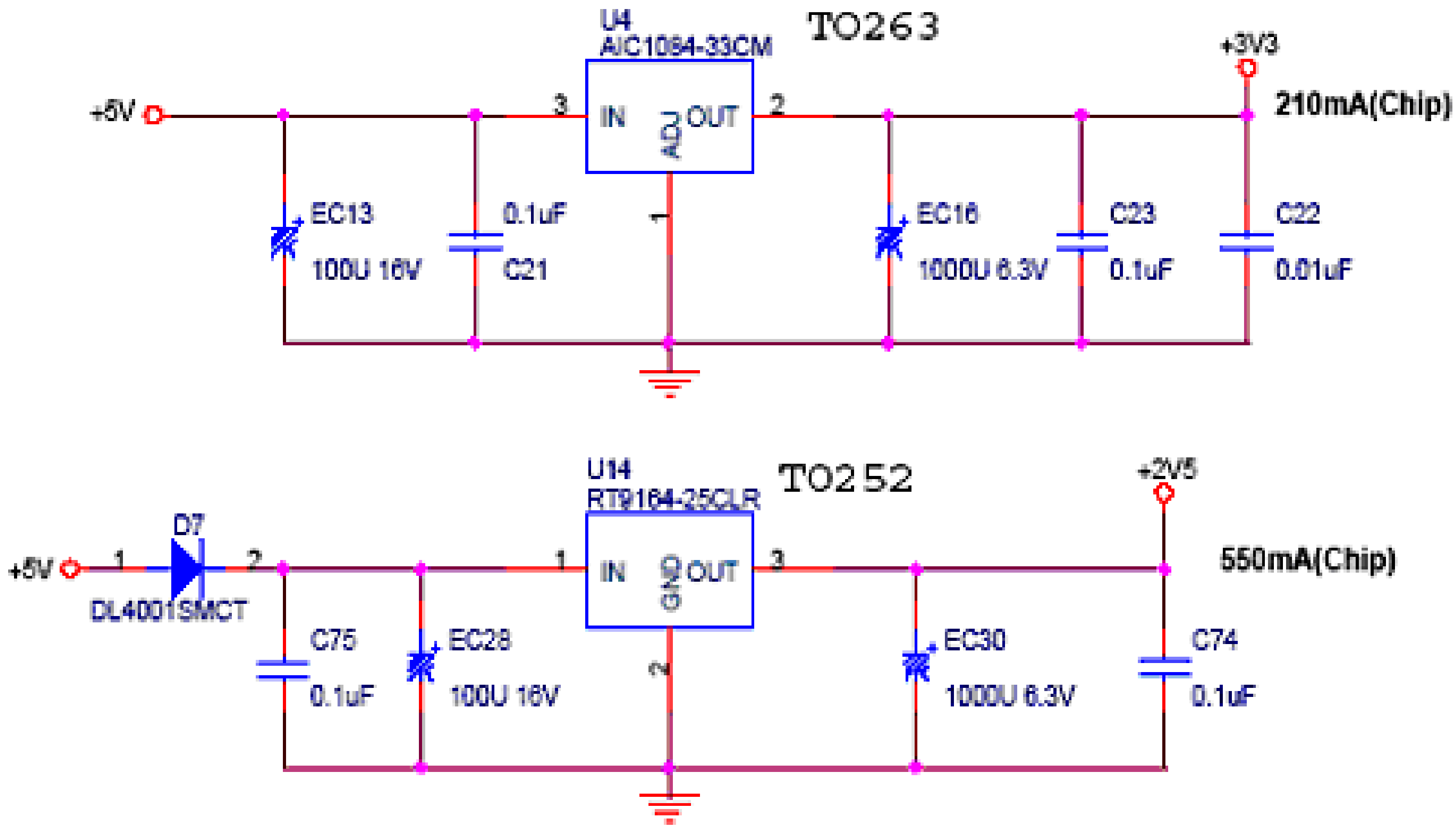
The main signal processing/controller board typically requires 3 power supply voltages - 5V, 3.3V, and 2.5V power supply.

A DC-to-DC converter is a switching power supply that bucks the input 12V down to 5V. The converter outputs a stable regulated 5V

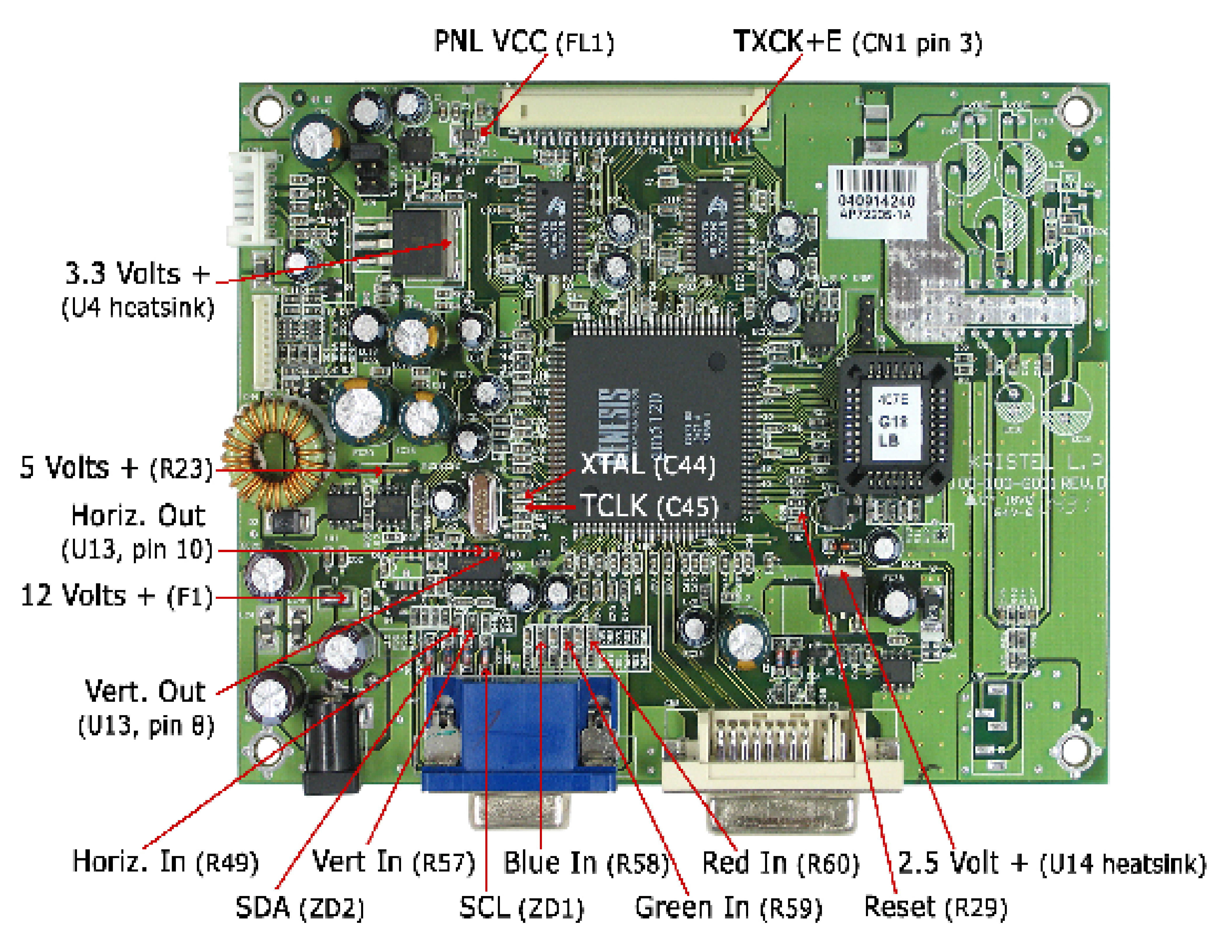
The 5V output feeds linear regulator ICs to drop voltages down to 3.3V and 2.5V outputs. The 3.3V and 2.5V DC supplies are conventional fixed voltage regulators.

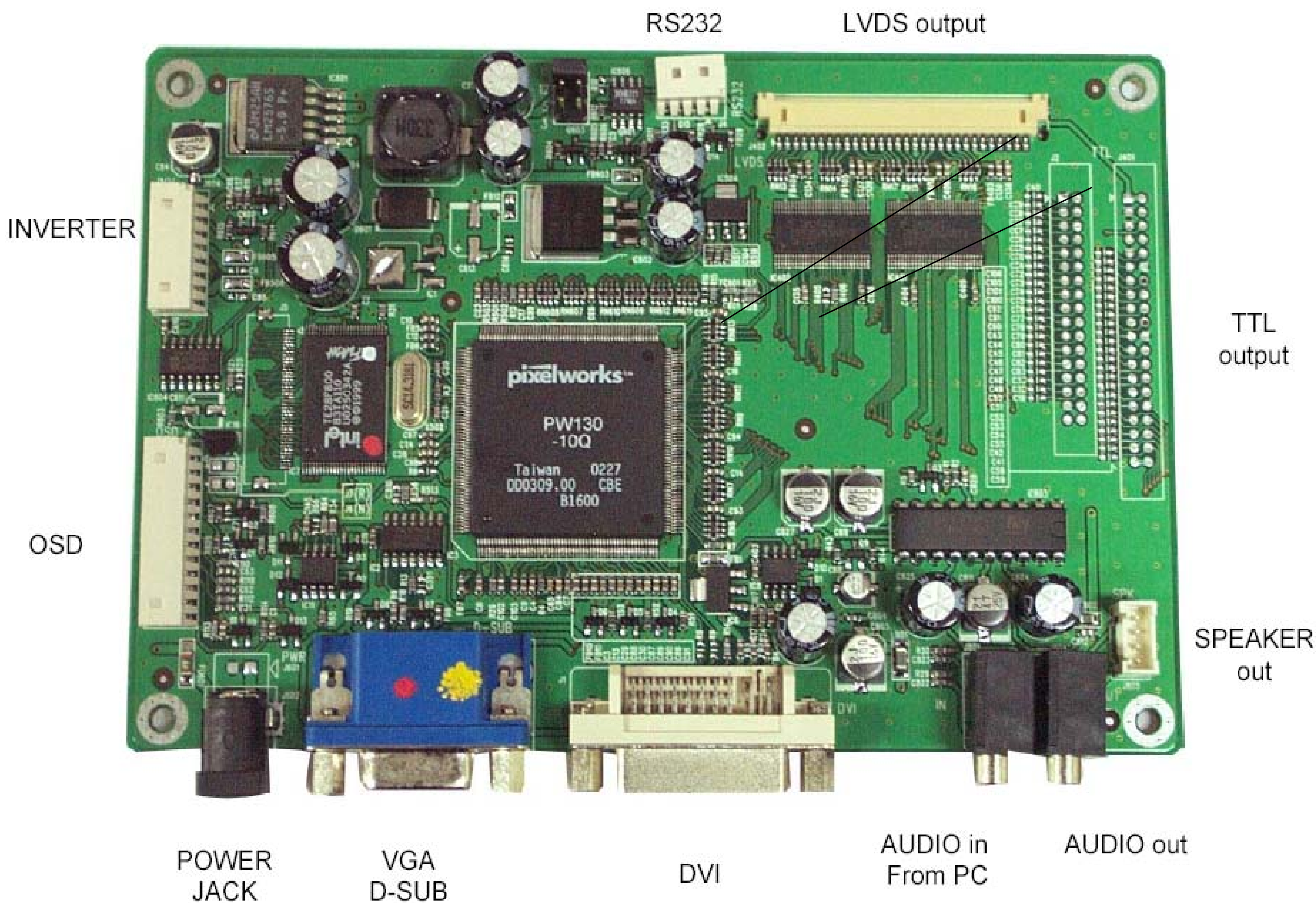
A Panel VCC supply selects (mechanical jumper) an input voltage and the microprocessor switches it (on/off) to the LCD panel.

Main Signal Processing/Controller Board Power Supplies



The 3.3V and 2.5V power supplies operate the digital ICs on the signal processor/controller circuit board. These supply voltages are derived from the 5V power supply. U14 is a surface mount linear regulator IC that outputs a regulated 2.5V. It is an IC package TO-252 and a suitable replacement is a PJ1117CP-2.5. U4 is also a linear regulator but physically larger. A suitable replacement is PJ1084CM.

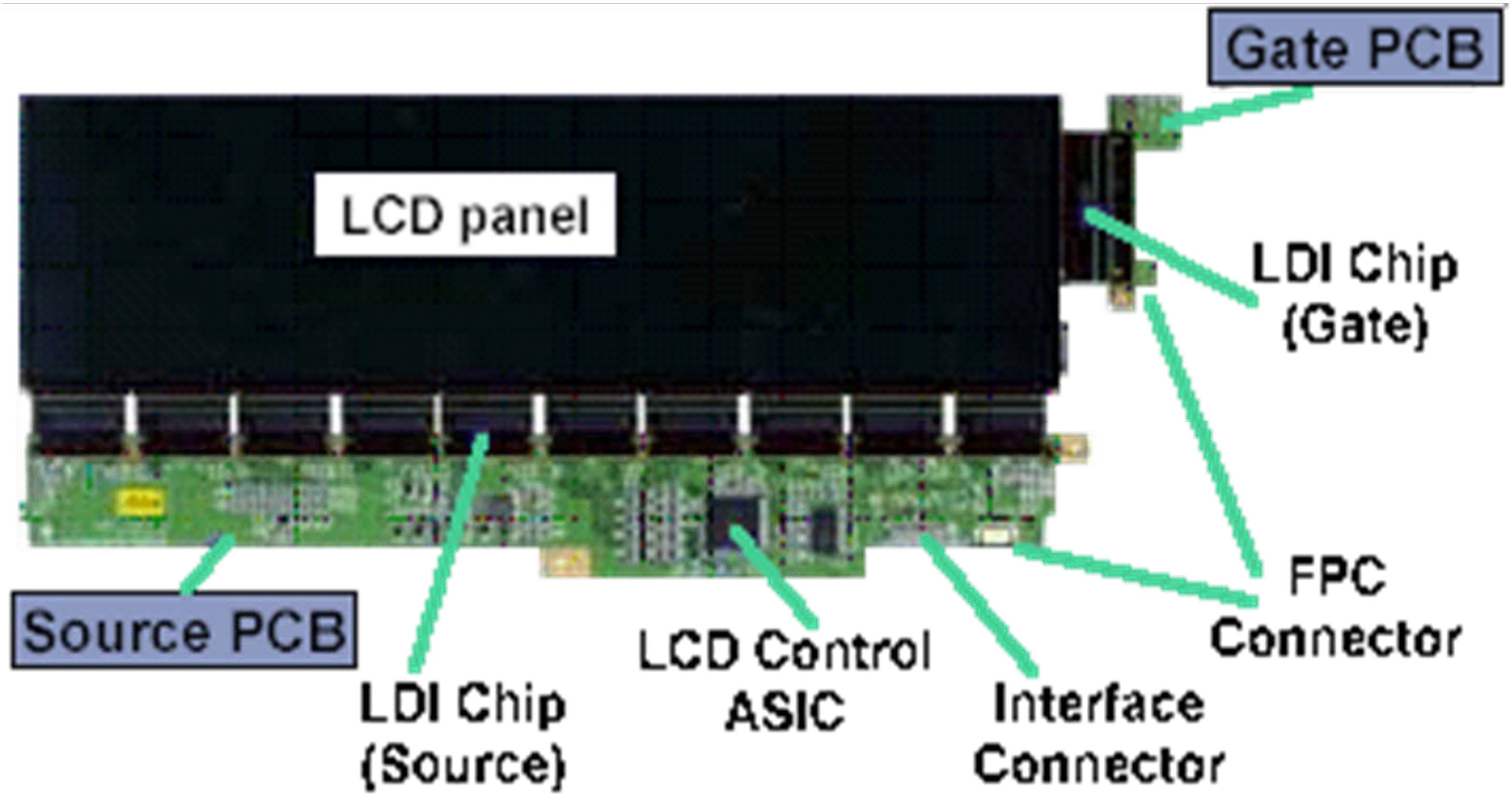

PNL VCC (FL1)
TXCK+E (CN1 pin 3)
3.3 Volts +
(U4 heatsink)
5 Volts + (R23)
XTAL (C44)
TCLK (C45)
Horiz. Out
(U13, pin 10)
12 Volts + (F1)
Vert. Out
(U13, pin 8)
Horiz. In (R49)
Vert In (R57)
Blue In (R58)
Red In (R60)
2.5 Volt + (U14 heatsink)
SDA (ZD2)
SCL (ZD1)
Green In (R59)
Reset (R29)



Signal processor/controller circuit board. (Courtesy Ceronix)

LCD Panel Construction

Driving an a-Si TFT LCD requires a driving circuit unit consisting of a set of LCD driving IC (LDI) chips and printed-circuit-boards (PCBs). The drive circuit unit can be placed on the backside of the LCD module by using bent Tape Carrier Packages (TCPs)



TAB (Tape Automated Bonding) process makes electrical connections with a TCP (Tape Carrier Package). A TCP is a small flexible tape material with many tiny electrical conductors. It must be precision positioned, heated and pressured into a bond completing the electrical connections. Specialized and expensive equipment is required for this process (Pulse-heated anisotropic- conductive film (ACF) equipment

Philips LM181 LCD Panel

Rear of Philips LM181 LCD panel

The circuit contains several DC power supplies – a balanced + and – 15V supply, 5V, and 3.3V supplies are typically. A DC input SMD fuse may be replaced.

An LVDS receiver/timing generator IC recovers LVDS input data and output timed signals to the column and row drivers to write to the display pixels.

A circuit board at the top edge contains driver IC used to drive the individual columns (source leads) and edge circuit board contains the driver ICs to drive the rows (gate leads) of the individual pixel transistors.

It can be removed but the circuit board is considered an integrated part of the panel.

Feeding the IC is the LVDS signals from the main signal processor board through a 30 pin connector. The wiring harness contains 10 twisted wire pairs for data and clock signals for even and odd pixels and enable, power supply lines.

LCD Panel – Insides – Philips LM181

Photo of the Plexiglas plate (right) and film layers in a disassembled LCD panel

To the rear of the LCD panel is a thick plexiglass plate (Upper right of photo). It provides dispersion of the light emitted from the CCFL lamps at the edges of the panel evenly across the back of the display.

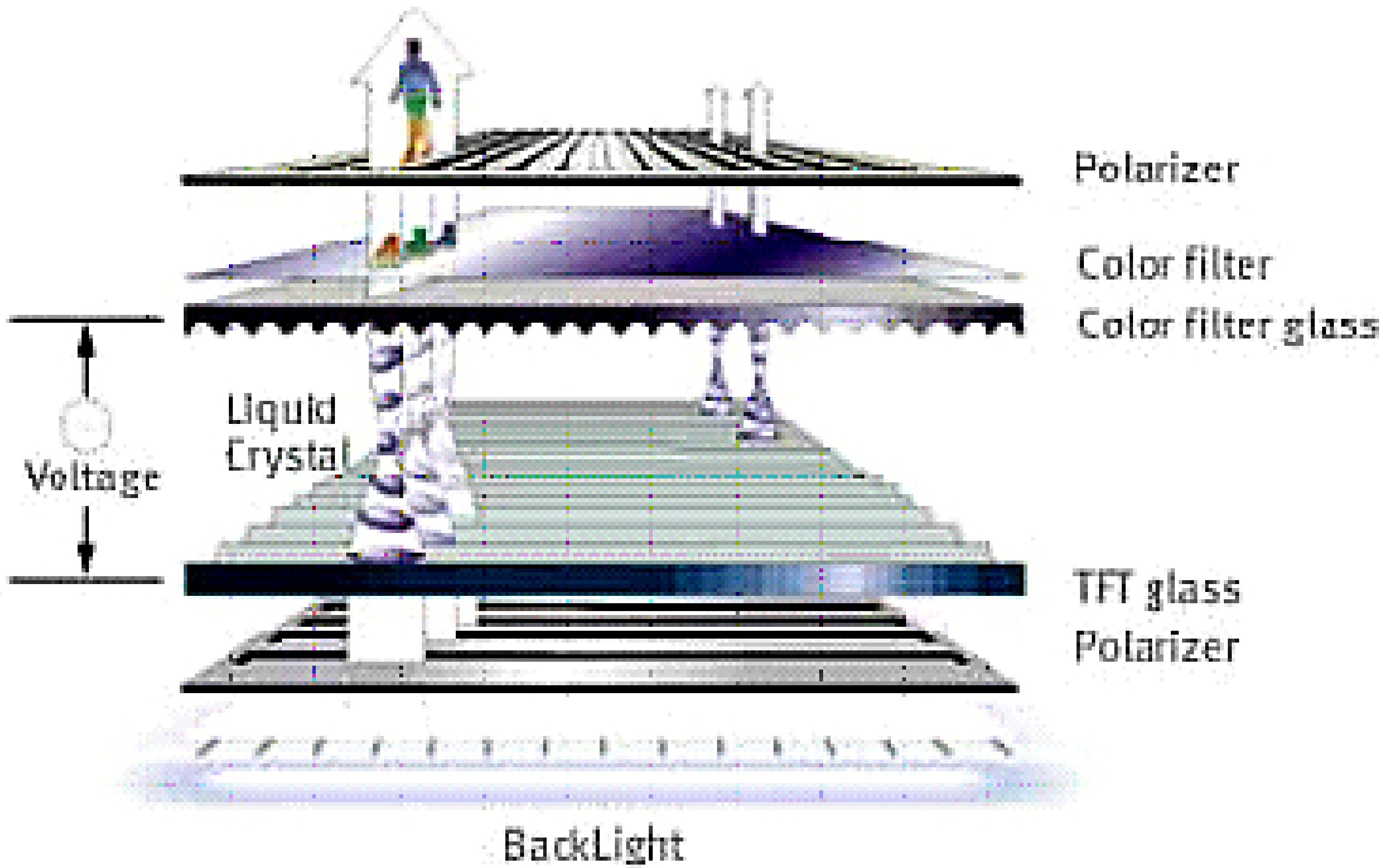
The sheets of material between the plexiglas and panel matrix serves to even further disperse the light and reflect it forward through the panel. A polarizer layer passes the light into the LCD panel at the proper polarity.

LCD Display Panel Backlight

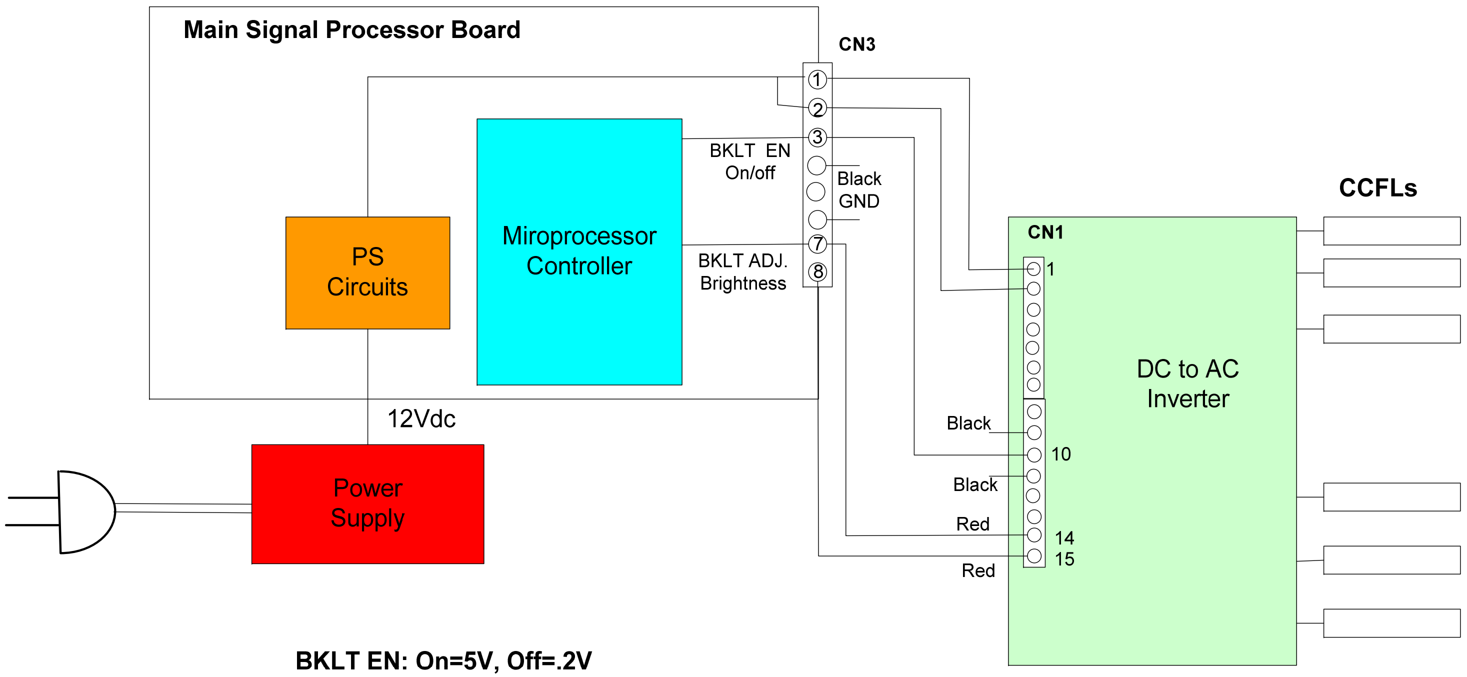
CCF tubes are currently the best light
source for the modern transmissive LCD modules currently being designed into many applications. They offer high brightness and high efficiency which makes them an ideal choice for
portable applications.

LCD Display Panel Backlight

The LCD display panel requires a light source. The light source is located behind the panel and is called the “backlight.” The light from the backlight source is directed through light diffusers and polarizer into the liquid crystal pixels. LCD panel backlights are CCFLs (Cold Cathode Fluorescent Lamps).



LCD Display Panel Backlight



Example of connection diagram from the main signal processing board to an inverter power supply in a Ceronix LCD monitor.

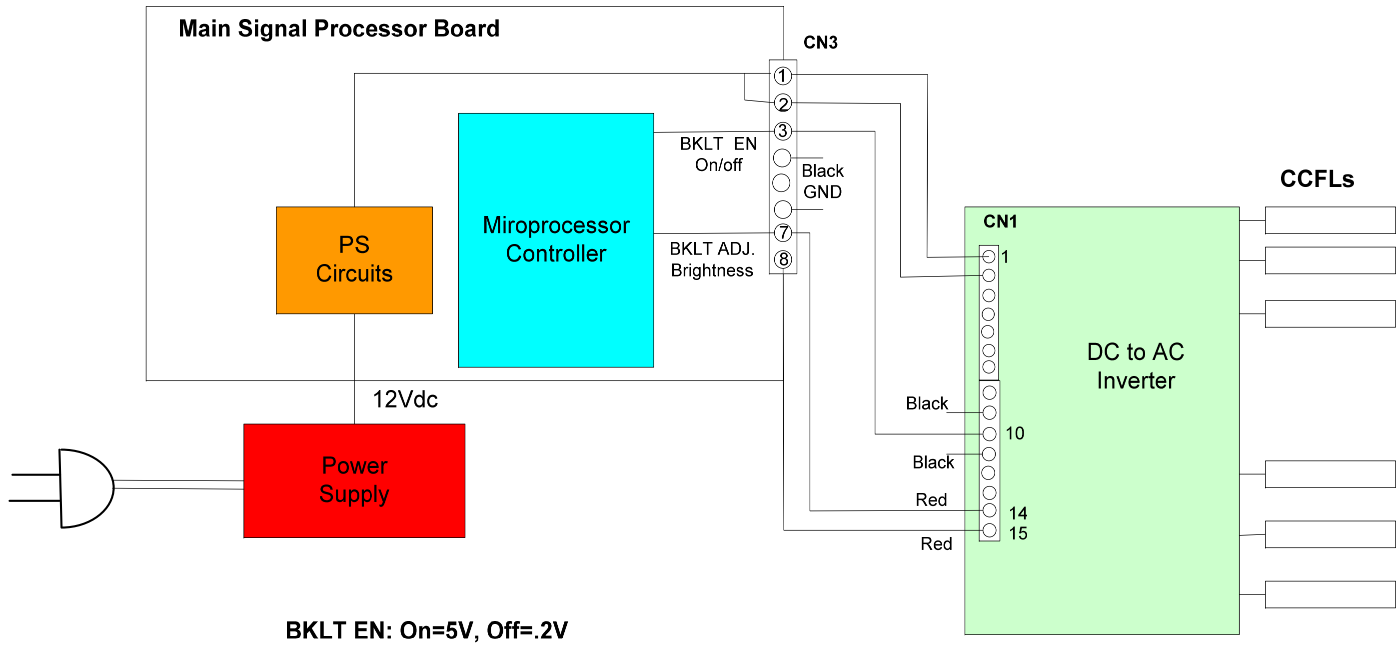
• A typical system used to power the CCFLs within an LCD display panel includes a DC to AC inverter power supply, microprocessor control, AC input power pack and DC to DC Converter Power Supply (Optional).

• The DC to AC backlight inverter converts the DC input voltage to a high voltage, high frequency AC sine-wave to power each CCFL.

• DC voltage applied to the inverter power supply powers the backlight inverter power supply and is the power source for output voltage to light the CCFLs.

• The DC input voltage originates from the AC to DC power supply or power pack powering the LCD color display

LCD Display Panel Backlight



Example of connection diagram from the main signal processing board to an inverter power supply in a Ceronix LCD monitor.

•The microprocessor controls the backlight inverter power supply.

• A backlight enable control line (BKLT EN or SW IN) switches the backlight inverter power supply on or off with a control DC voltage change.

• The microprocessor also controls the light output of the CCFLs to provide user brightness control of the LCD display panel.

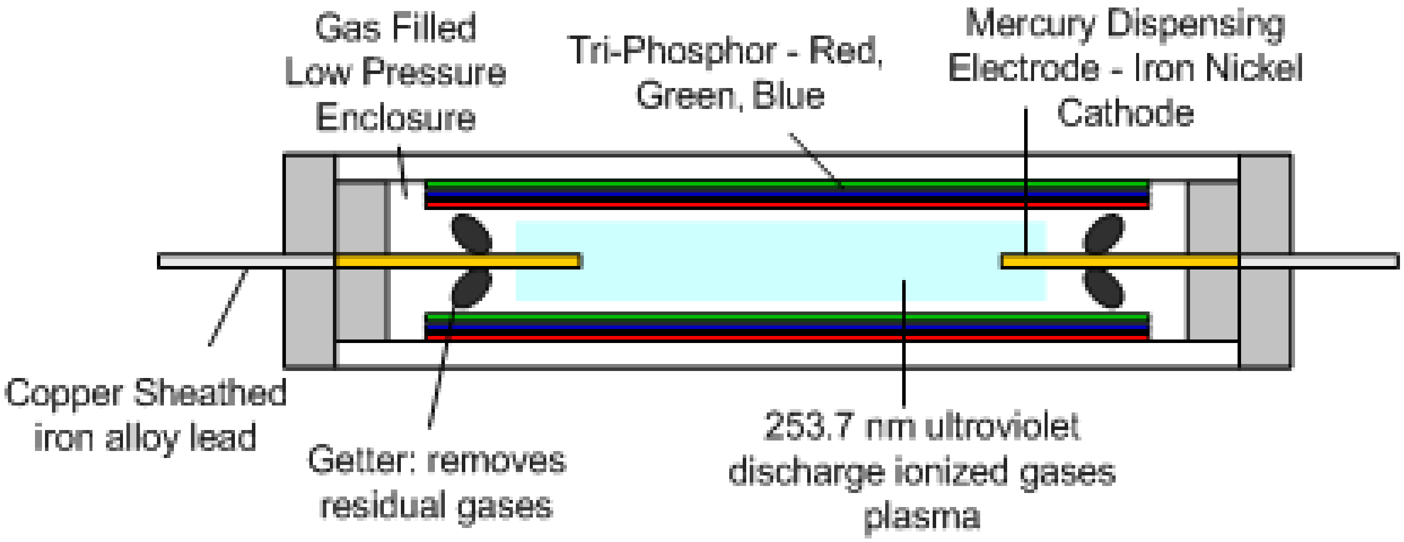
• The microprocessor provides a DC voltage change or pulse width modulation change in which circuitry within the DC to AC inverter uses to control CCFL lamp current to change light brightness.

LCD Display Panel Backlight

Cold Cathode Fluorescent Lamps (CCFL)

CCFL lamps are more efficient in comparison to other light sources. CCFL bulbs convert about 20% of the applied energy into light in the 380-780 nm range. Lamp diameter and length vary which effect their operating parameters.

LCD Display Panel Backlight



The cold cathode electrodes of the lamp are comprised of a nickel plated iron structure, containing pockets of mercury during lamp manufacturing.

The cathode structure retains the mercury until released by heating the structure using RF energy after the lamp envelope is sealed.

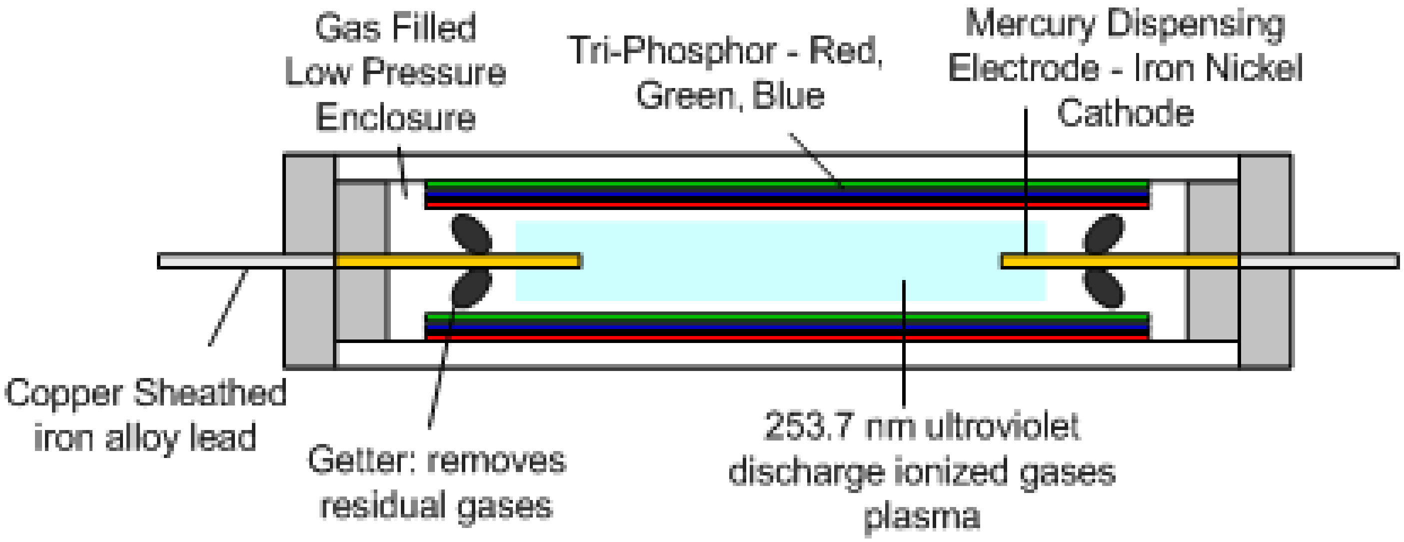
The typical CCFL contains from 2-10 mg of mercury.

The cathode structure contains a getter material on its surface to remove damaging residual gases.

The getter material is comprised of an allow of 84% ZR and 16% Al. With a lamp operated from alternating current the cold cathodes alternate polarity.

The phosphor coating on the inside of the glass envelope is a tri-phosphor RGB type. It is composed of red, green, and blue emitting phosphors. Varying the phosphor ratios change the white light emitted.

LCD Display Panel Backlight



Summary:

1. Cold cathode electrodes – nickel plated iron – initially contains pockets of mercury.

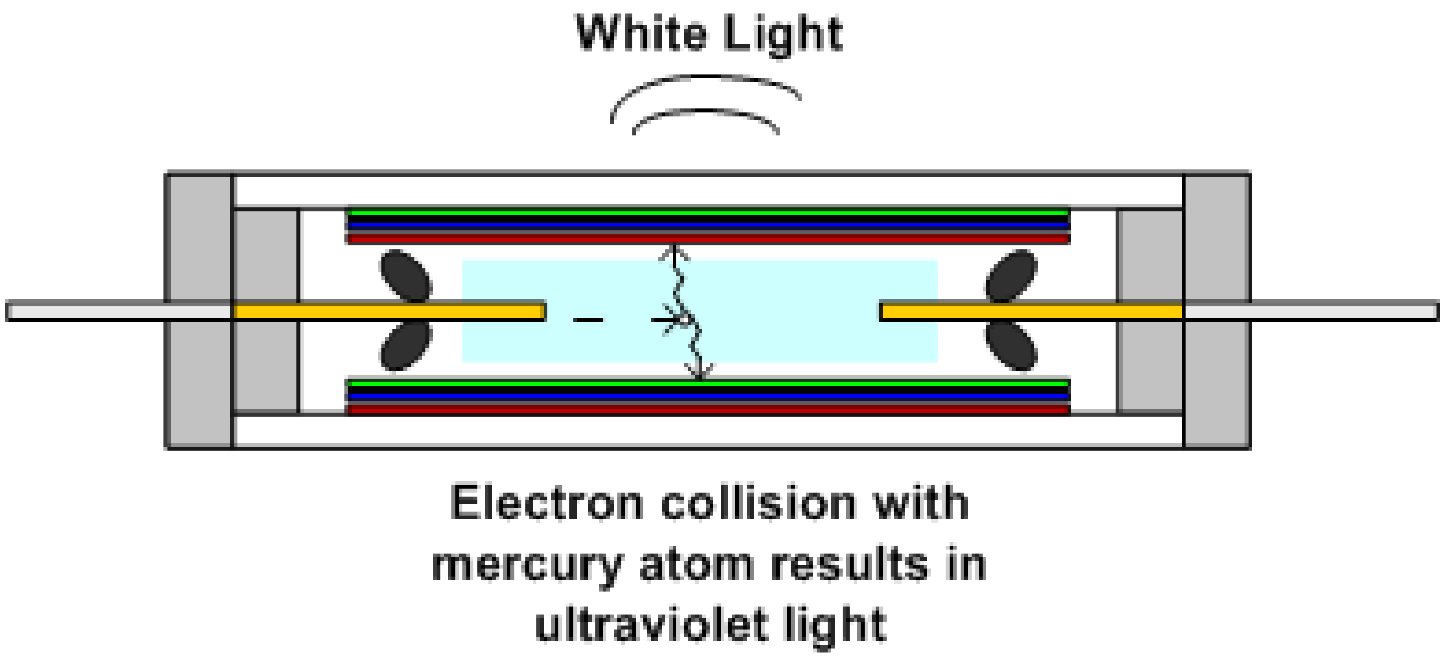
2. Mercury dispensed into lamp after it is sealed using RF energy – 2-10 mg mercury in typical CCFL.

3. A getter element works to remove unwanted gases from the sealed enclosure. The getter is comprised of 84% Zr and 16% AL.

4. Tri-phosphor coating on the inside of the glass enclosure contains red, green and, blue emitting phosphors

5. The sealed envelope contains mercury and fill gas (argon) with a pressure of 2-6 Torr. (Low Pressure)

LCD Display Panel Backlight



1. Voltage introduced into the lamp via the cold cathode electrodes on each end of the lamp.

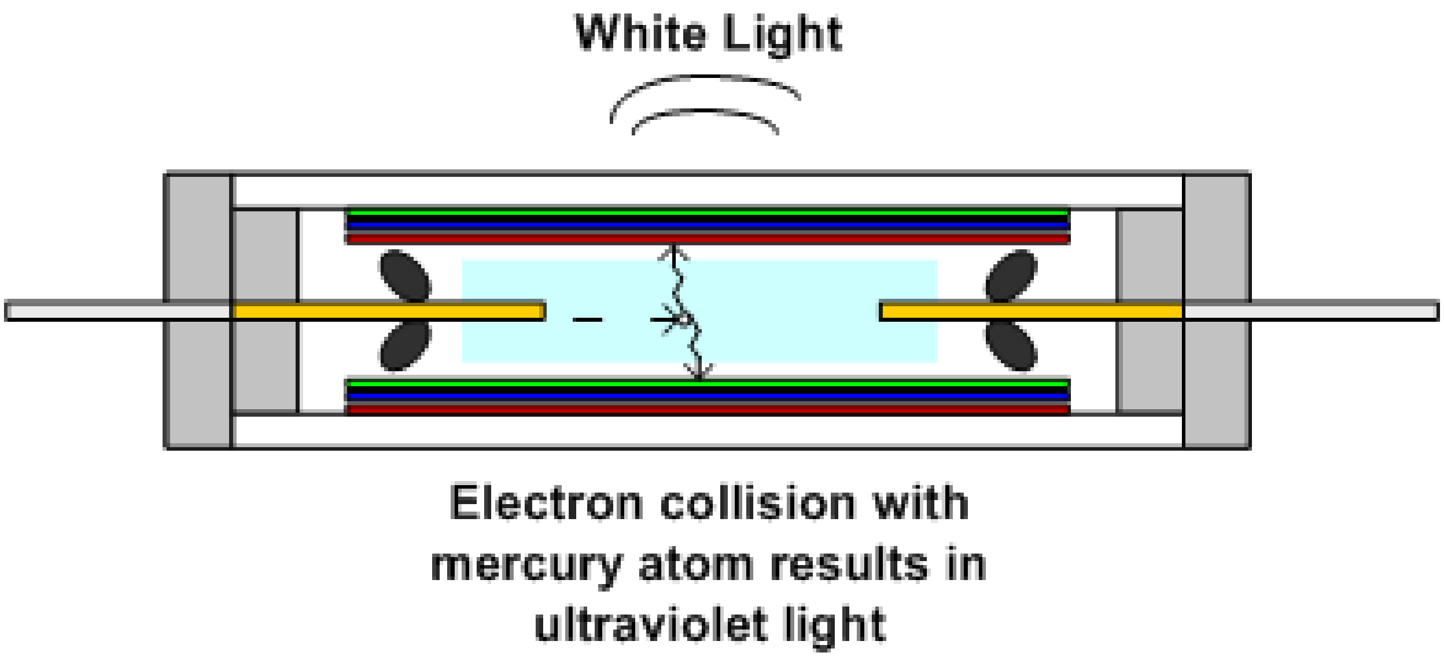
2. The applied voltage accelerates electrons between the 2 electrodes.

3. The applied electrical voltage is actually a high voltage AC so the electrodes alternate being cathode & anode and the current alternates.

4. Electrons traveling between elements collide with mercury atoms releasing ultraviolet energy.

5. The ultraviolet discharge or ionization of the mercury stimulates the phosphor increasing the 253.7 nm wavelength (ultraviolet) energy to visible light frequencies (red, green, blue). Equal energy red, green and blue results in white light emitted from the lamp.

LCD Display Panel Backlight



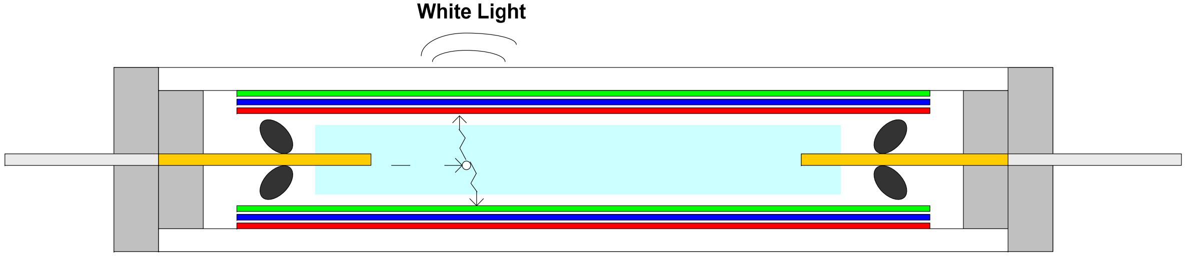
1. Ionization is enhanced by adding a fill gas (argon). Adding argon enhances ionization and lowers the required voltage. The fill gas (argon) excites the argon atoms releasing an electron which may also collide with a mercury atom enhancing ionization. Ultraviolet energy strikes the phosphors resulting in white light

CCFLs overtime suffer from phosphor degradation.
Results: Not as much light output.

Ion bombardment of phosphor over time causes inner surface of phosphor to become non-luminescent.

Ion bombardment of phosphor over time causes some phosphors to absorb mercury.

CCFL tubes as they age require more and more start voltage. Eventually they can't start resulting in no light output.



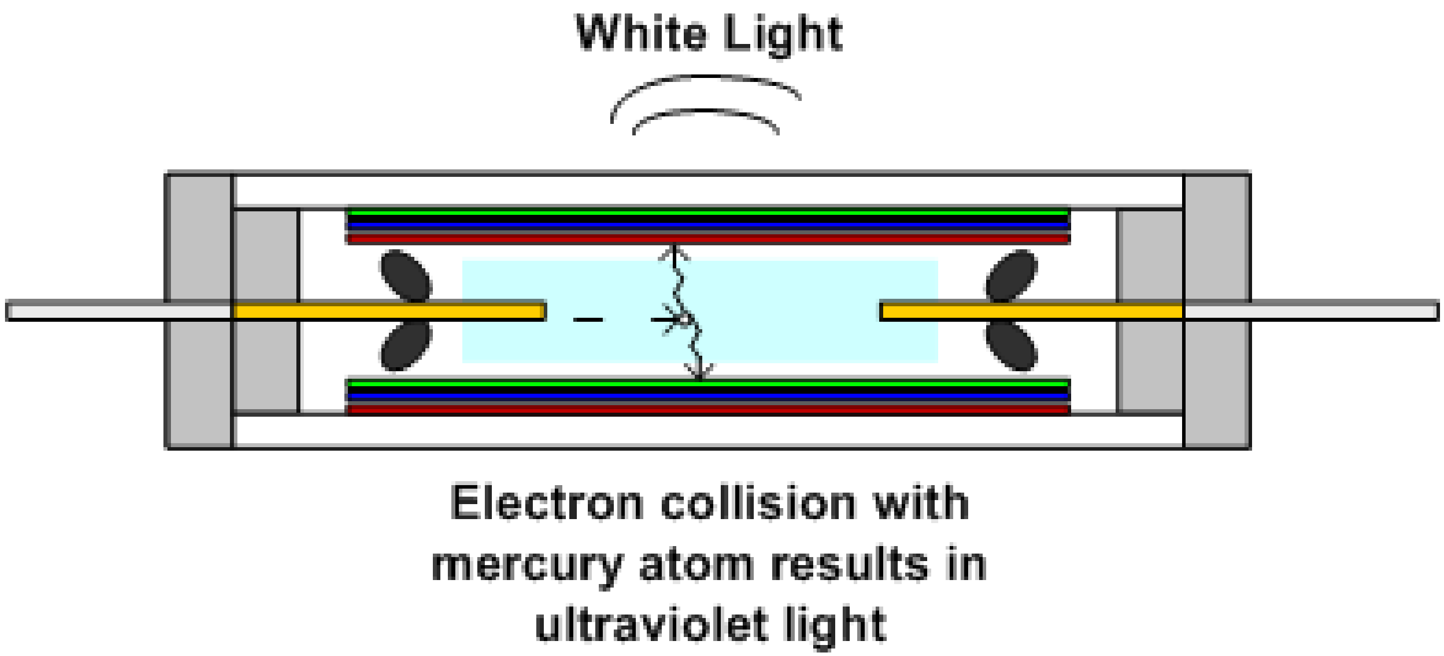
Typical CCFL life rating spec.: 20,000 hrs to 50% of the lamps at drive current of 5 mArms

(24 hr. display operation = 833 days or 2.28 years)

<u>LM181E06 LCD Module</u>

<u>Lamp Life Time: 40,000 Hrs (Brightness 50% of initial</u>

LCD Display Panel Backlight



1. Voltage introduced into the lamp via the cold cathode electrodes on each end of the lamp.

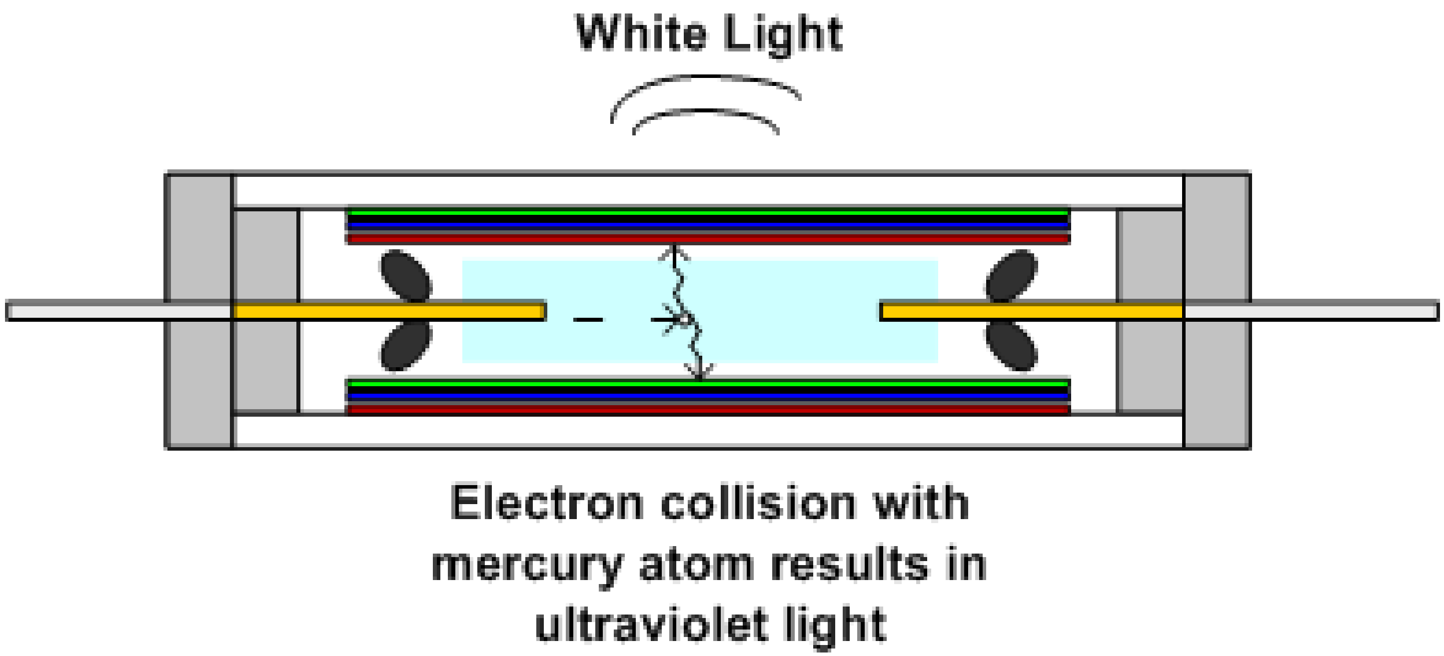
2. The applied voltage accelerates electrons between the 2 electrodes.

3. The applied electrical voltage is actually a high voltage AC so the electrodes alternate being cathode & anode and the current alternates.

4. Electrons traveling between elements collide with mercury atoms releasing ultraviolet energy.

5. The ultraviolet discharge or ionization of the mercury stimulates the phosphor increasing the 253.7 nm wavelength (ultraviolet) energy to visible light frequencies (red, green, blue). Equal energy red, green and blue results in white light emitted from the lamp.

LCD Display Panel Backlight



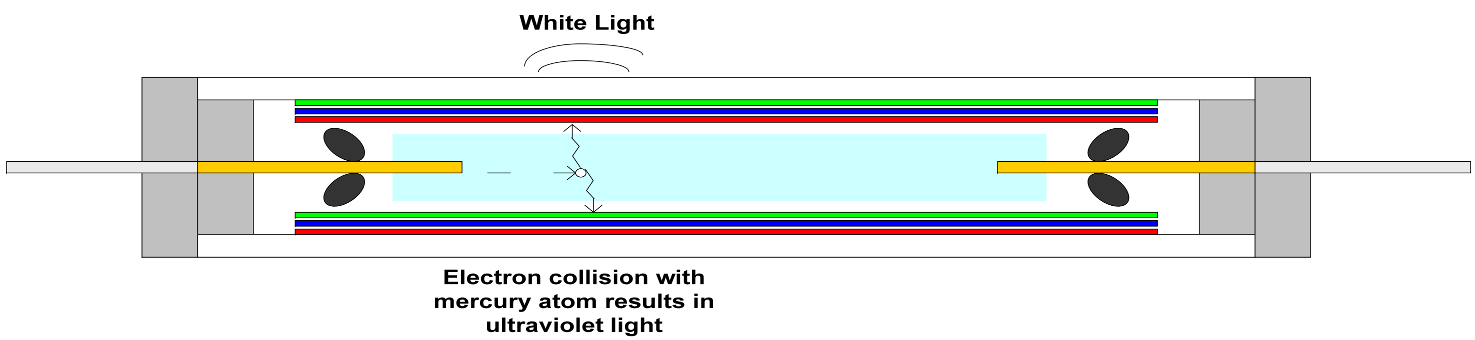
1. Ionization is enhanced by adding a fill gas (argon). Adding argon enhances ionization and lowers the required voltage. The fill gas (argon) excites the argon atoms releasing an electron which may also collide with a mercury atom enhancing ionization. Ultraviolet energy strikes the phosphors resulting in white light

CCFLs overtime suffer from phosphor degradation.
Results: Not as much light output.

Ion bombardment of phosphor over time causes inner surface of phosphor to become non-luminescent.

Ion bombardment of phosphor over time causes some phosphors to absorb mercury.

CCFL tubes as they age require more and more start voltage. Eventually they can't start resulting in no light output.



Typical CCFL life rating spec.: 20,000 hrs to 50% of the lamps initial output at drive current of 5 mAmps.

(24 hr. display operation = 833 days or 2.28 years)

LM181E06 LCD Module

Lamp Life Time: 40,000 Hrs (Brightness 50% of initial value)

Finding Replacement CCFLs or Inverter Power Supplies

Backlight Inverter Power Supply Sources:

Endicott Research Group Inc.(ERG) is a manufacturer of replacement backlight inverter power supplies for most LCD modules. A complete list obtained at www.ergpower.com

Applied Concepts Inc. - source for replacement backlight inverter power supplies www.acipower.com

More sources are available by searching the world wide web.

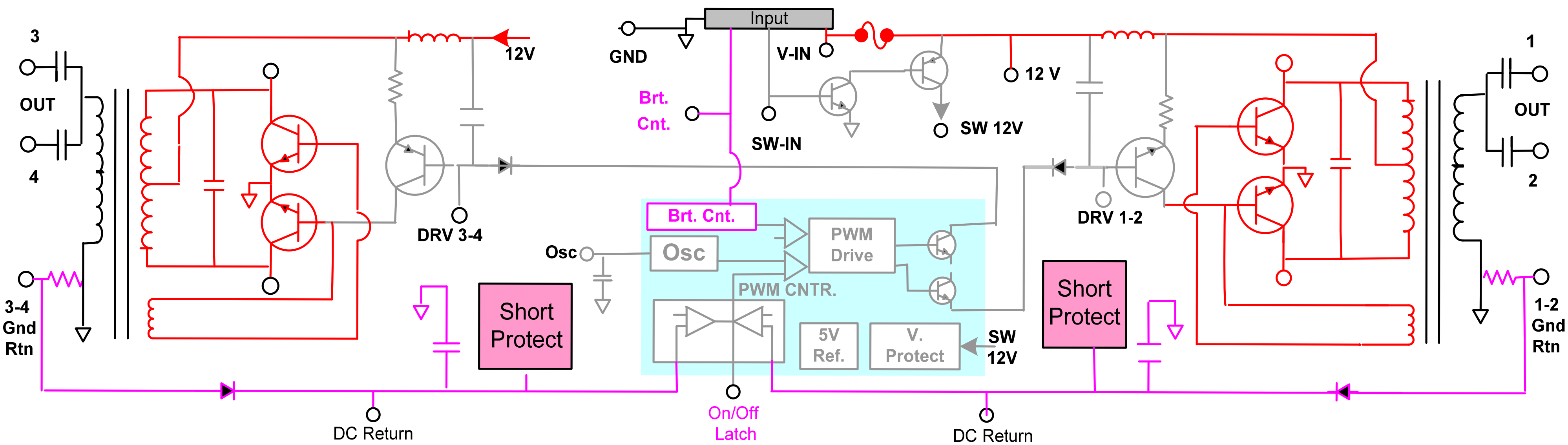
CCFL Sources:

A large manufacture of CCFL lamps is JKL Components Corp. They offer a large selection of replacement lamps. More information www.jkllamps.com or 1-800421-7244.

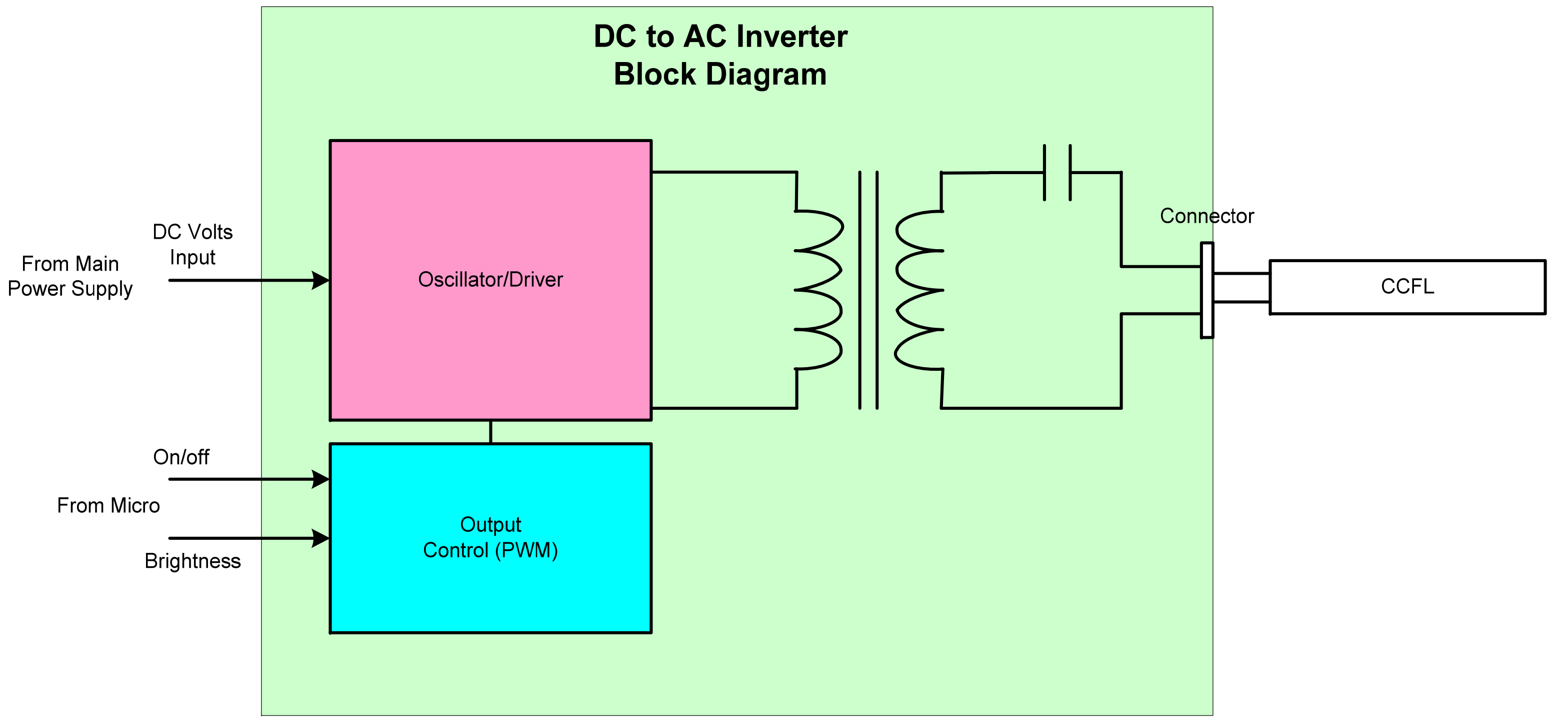
Other parts suppliers offer JKL lamps including DigiKey and Mouser Electronics

Moniserv is a computer monitor repair depot that offers LCD panel repair and offers replacement CCFL lamps, CCFL assemblies, and inverter power supplies. See www.moniserv.com

Backlight Inverter Power Supply Theory



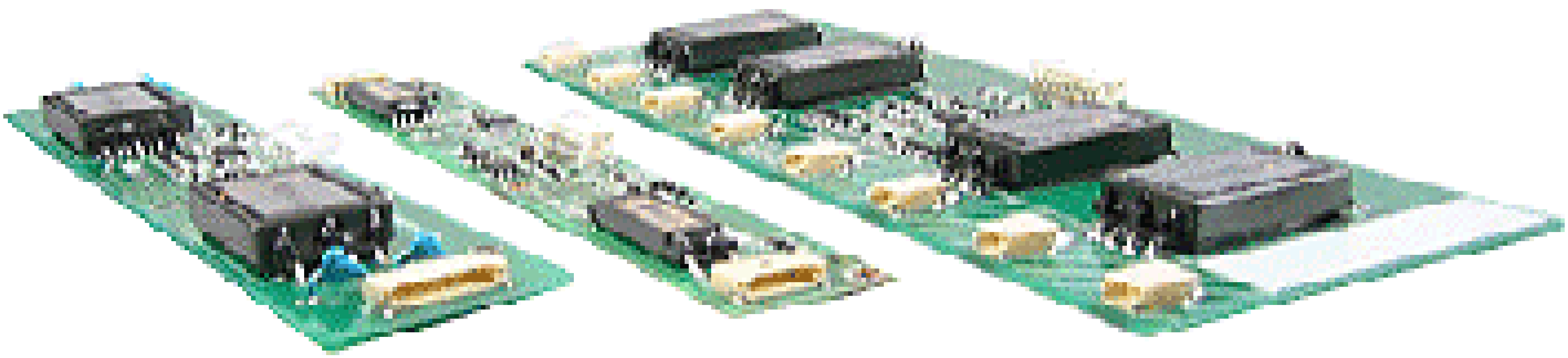
Backlight Inverter Power Supply Theory



* The backlight inverter power supply has an oscillator that generates an AC output voltage.
* A voltage input ranging from 8-14V powers the oscillator.
* A transformer outputs secondary winding AC voltage to the CCFL bulb(s).
* The output is also tuned with a capacitor forming a resonant circuit with the CCFL in series.
* An IC controls the oscillator through a driver transistor and can turn the oscillator on and off.
(This provides on/off control and brightness control of the CCFL lamps.)
* An additional voltage input is used to switch voltage to the control IC to turning the supply on and off.
* A third input is a brightness control input from the microprocessor.

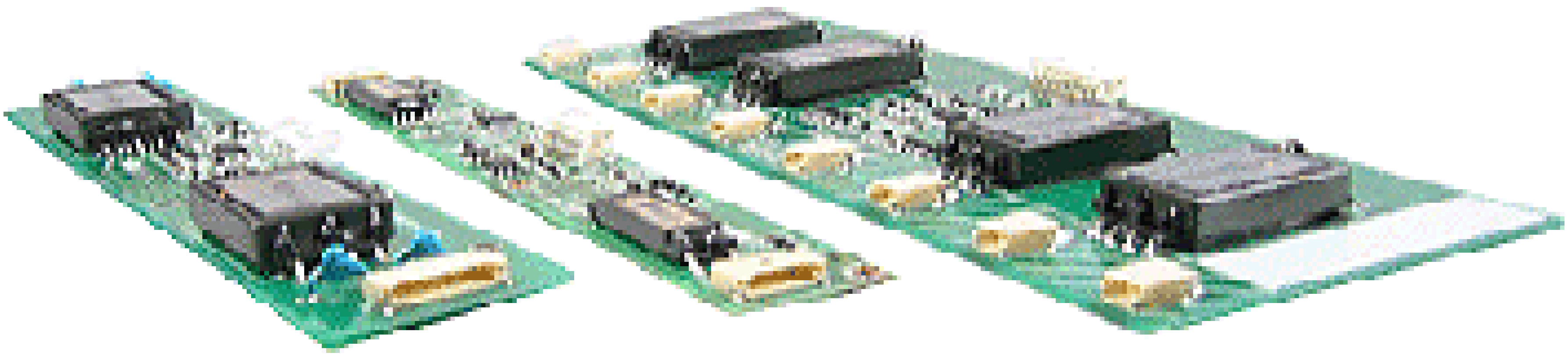
Backlight Inverter Power Supply Theory

* LCD panels have multiple bulbs.
• Popular computer monitor LCD panels ranging 18-19 inch have 4 or 6 CCFL bulbs.
• Larger LCD panels may have more CCFL bulbs.
• The inverter power supply must be designed to output to each of the CCFL bulbs in a particular LCD panel.



Backlight Inverter Power Supply Theory

Example: Minebea Electronics – Hamamatsu Manufacturing

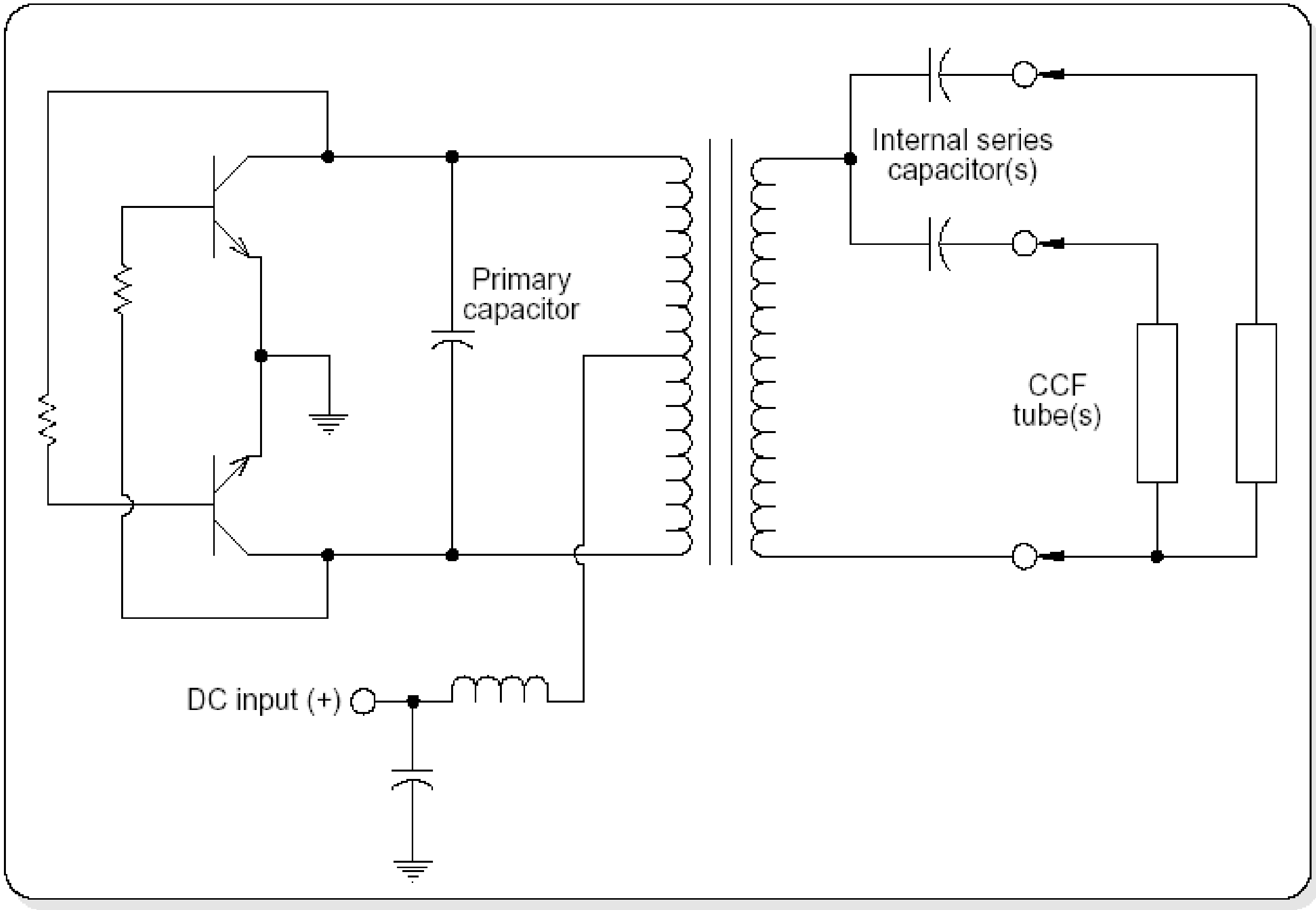


High lamp current accuracy	:	4%
Efficiency	:	85% typ
Protection circuits	:	Over voltage protection
	:	Open voltage protection
	:	Over current protection
	:	Short circuit protection
	:	Thermal shutdown

Input voltage	:	10.8V ~ 20.0V
Output power	:	6.0W/1 lamp max
Efficiency	:	85% typ
Operating	:	40KHz ~ 70KHz
Dimming signal	:	DC control or PWM control
Dimming renge	:	100% ~ 10%

Backlight Inverter Power Supply Theory

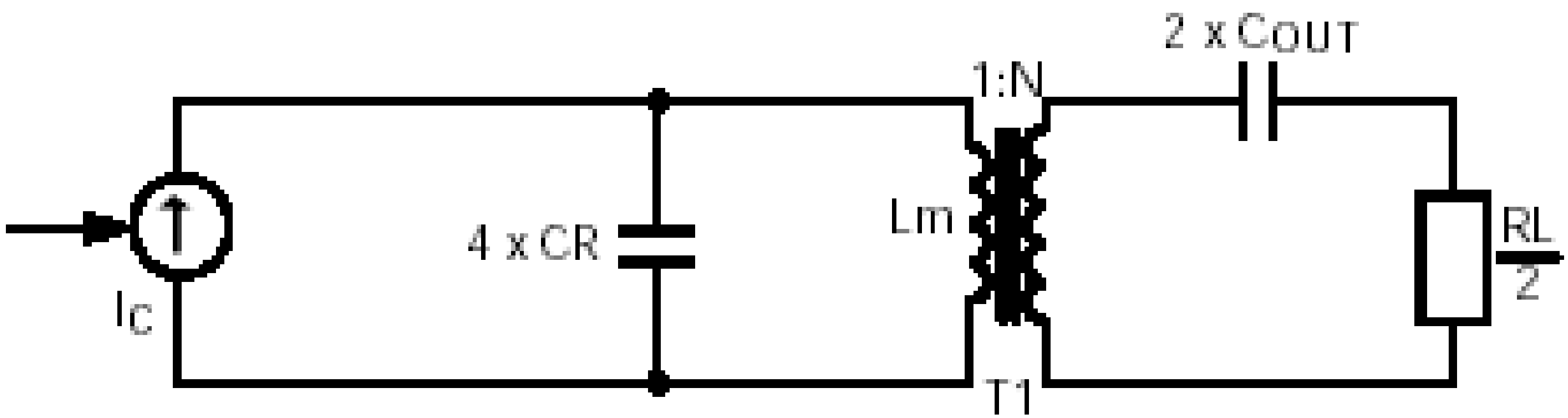
Typical backlight inverter supply uses a two transistor inverter circuit based upon a royer oscillator.
The oscillator forms a tuned resonant primary circuit.
The transformer secondary, capacitor & CCFL bulb form a secondary resonant circuit.
The tuned circuits produce a sine-wave output to the CCFLs. The design is 80-90% efficient.



A common backlight inverter power supply circuit has a royer oscillator primary and tuned secondary.

Inverter Tuned Circuit

The inverter transformer tunes with the resonant capacitor CR to set the resonant frequency of the inverter.



Since the circuit operates at resonance the impedance seen by the above current source is resistive and equal to the transformed impedance of the lamp.

The typical value for RL is 100K ohm. For a typical operating frequency of 50kHz.

Backlight Inverter Power Supply Theory

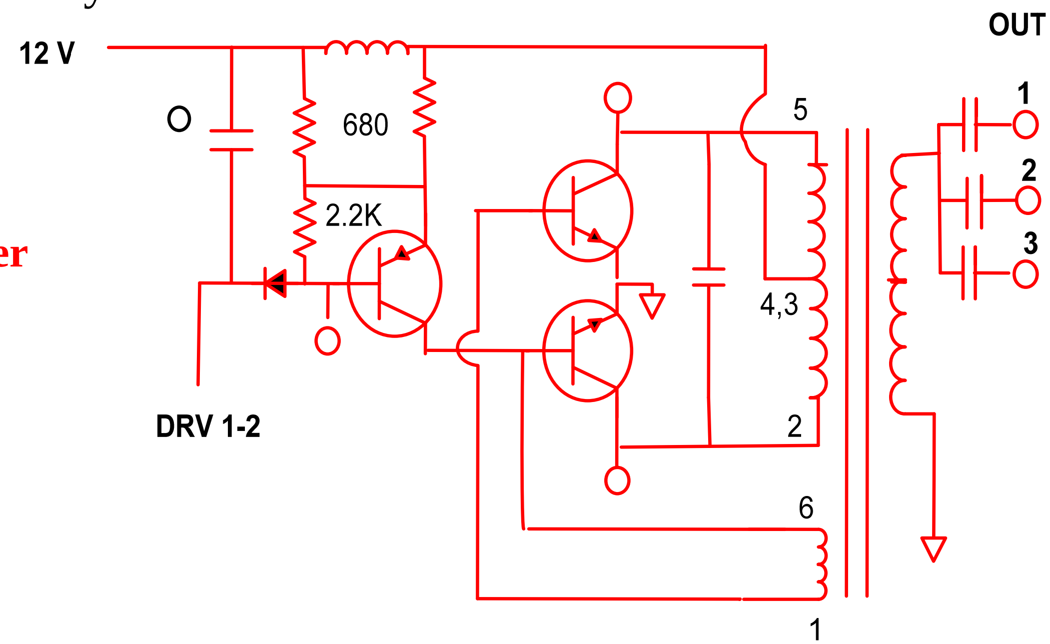
- The royer oscillator primary contains two amplifier transistors to sustain oscillation produced by the transformer primary and primary capacitor.

- A center tap DC current input powers the oscillator.

- Each end of the transformer primary contains feedback to the base of one of the transistors.

- The transistors alternately conduct via the feedback from the out-of-phase transformer primary ends. Inductance and capacitance values produce a frequency of 20-100 kHz.

Royer Oscillator In LCD Trainer Inverter



Backlight Inverter Power Supply Theory

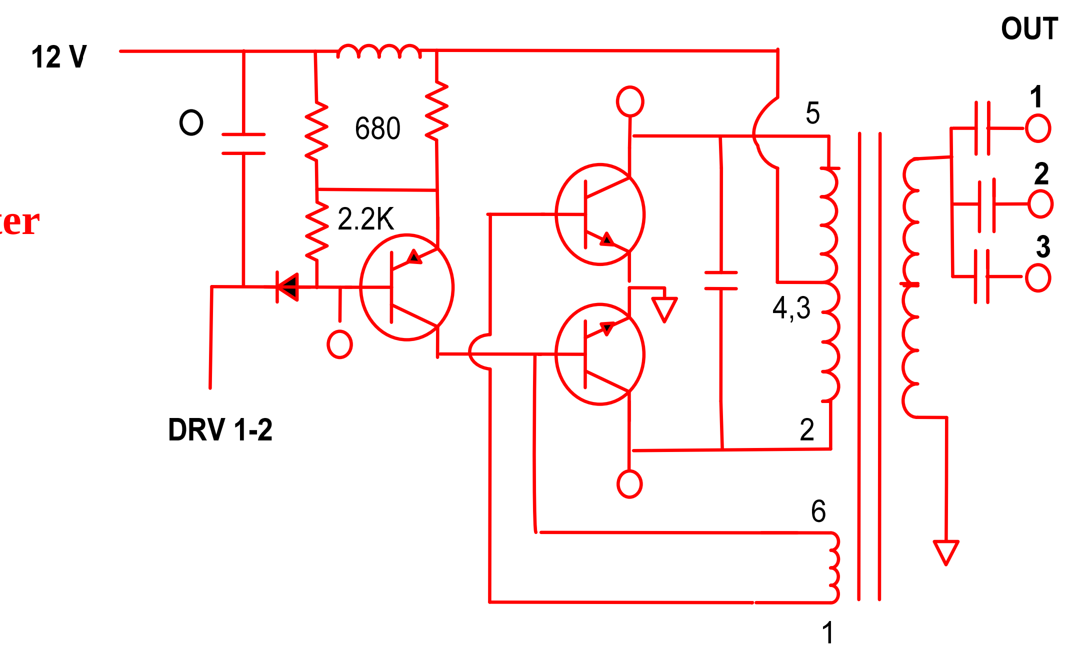
•The sec. series capacitor ranges 12pfd to 39 pfd.

• Its Xc is high Z in series with the output.

• The sec. capacitor starts the CCFL lamps.

• The capacitor acts as a ballast, providing high Z during startup & higher output voltage to CCFLs. *Once the lamps are on, the capacitor impedance is responsible for a constant current output to the CCFL lamps. The circuit produces its nominal output current into any load condition including a short circuit.*

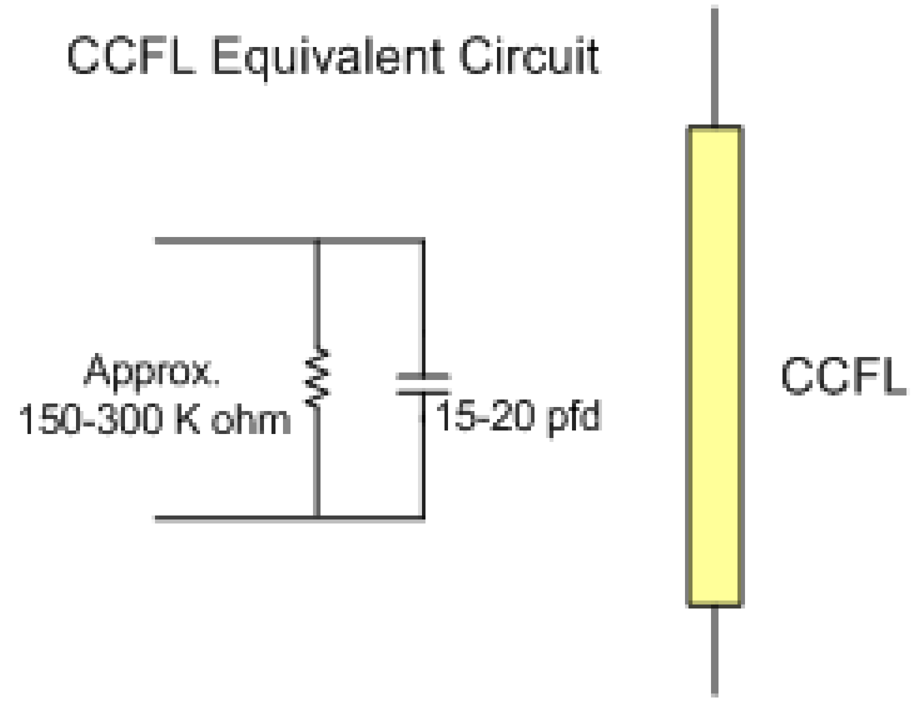
Royer Oscillator In LCD Trainer Inverter



Backlight Inverter Power Supply Theory

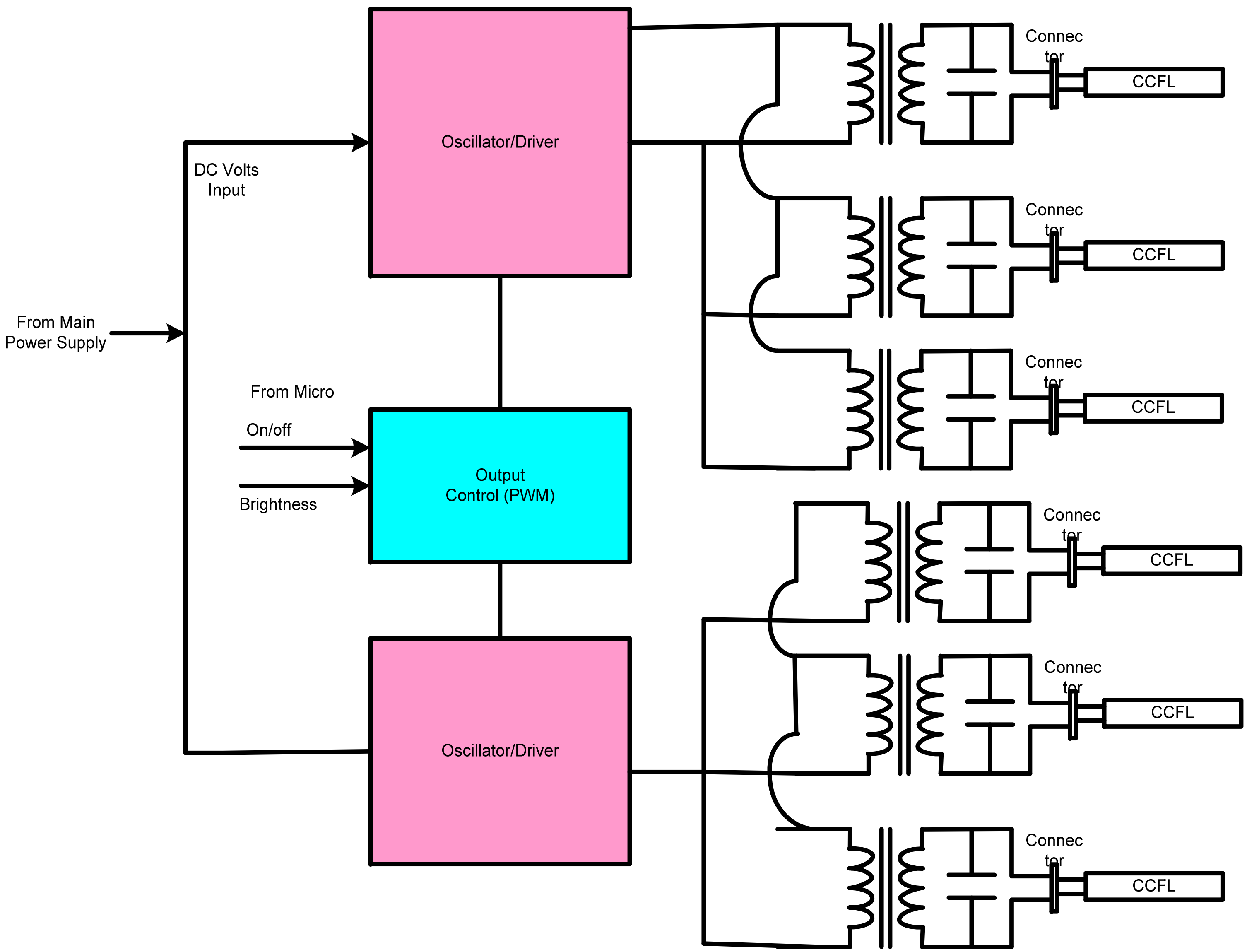
The impedance of the lit lamp ranges from 50k -200 k ohm depending on the lamp size and diameter.

The impedance of the unlit lamp is infinite or open.



The CCFL equivalent circuit when lit is resistive in the range of 50 – 200 K ohms

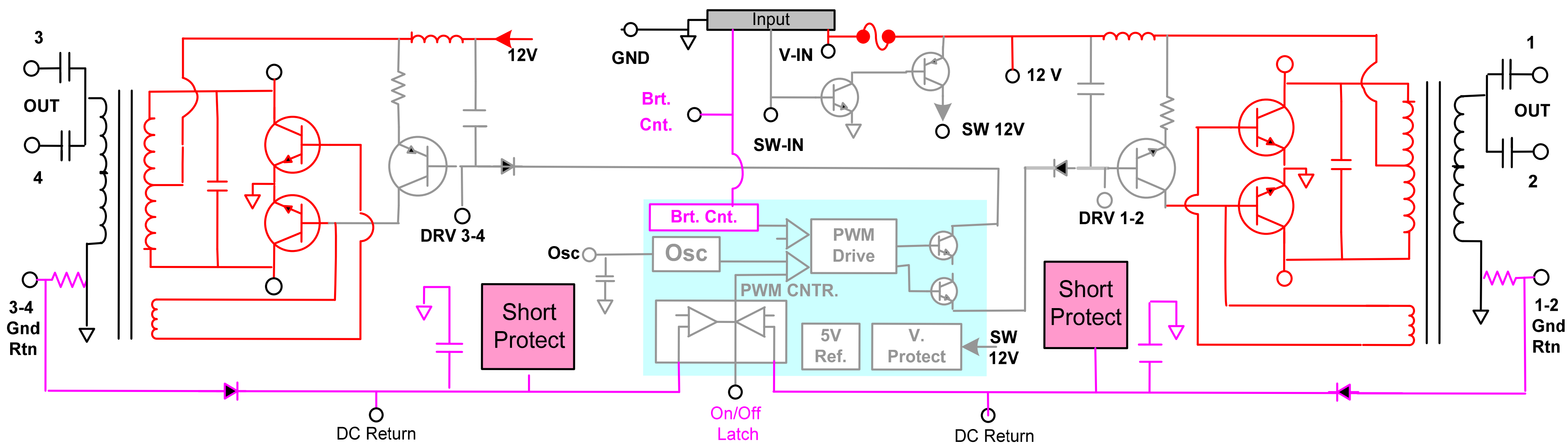
DC to AC Inverter
Block Diagram



Inverters may have multiple sections feeding multiple CCFLs

Backlight Inverter Power Supply Theory

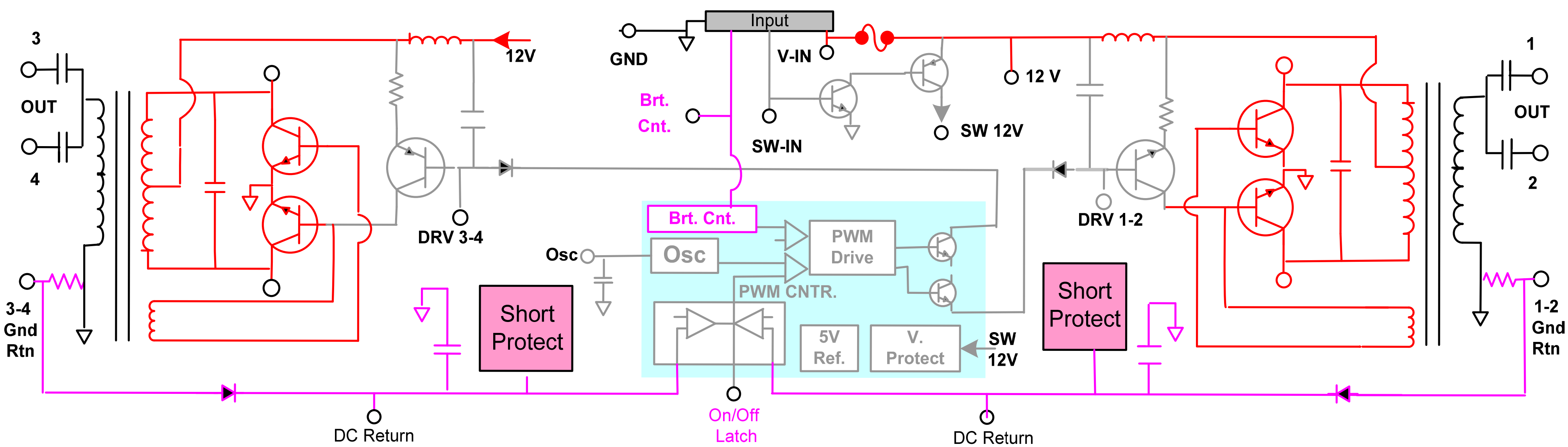
• Simplified schematic of the backlight inverter power supply - Sencore LCD trainer.
• Two royer oscillators (red)
• Oscillators switched on/off and controlled by a common controller IC (blue).
• The controller IC has two outputs to drive 1-2 and drive 3-4 transistor which turn on/off the oscillators (red).



Simplified schematic of LCD Computer Monitor Trainer showing two oscillator sections (red) controlled by common IC controller.

Backlight Inverter Power Supply Theory

- The inverter power supply IC is switched on/off by SW-IN input to the supply.
- The SW-IN voltage biases on a dual transistor switch passing voltage to the voltage input to the IC (SW-12V)
- Once powered, the IC begins to develop drive with an internal IC oscillator and external RC time constant.
- The sawtooth waveform may be measured at the OSC test point.
- The IC oscillator is used to output to the drive transistors for brightness control PWM.
- An op-amp comparator in the IC provides shutdown protection by disabling its drive output in the event of excessive output voltage, open load protection, or short circuit protection.
- Transformer secondaries contain multiple series capacitors to feed multiple CCFL bulbs. Two outputs are shown by the
- diagram but 3 outputs are used to feed the Philips LM181 panel used by the Sencore LCD computer monitor trainer.



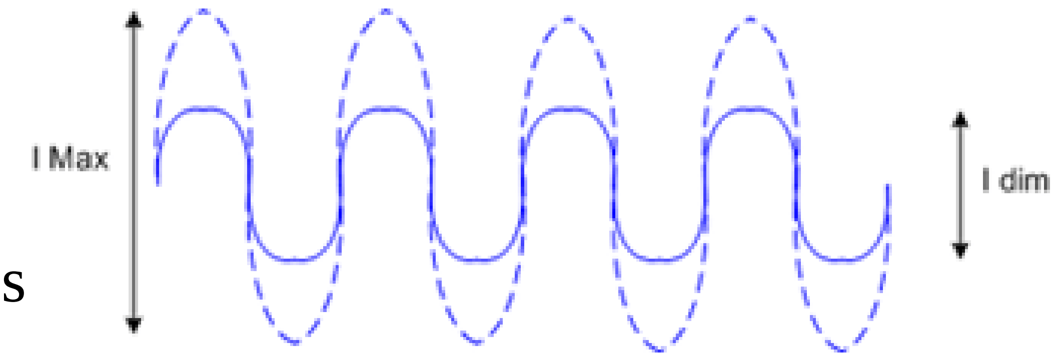
Simplified schematic of LCD Computer Monitor Trainer showing two oscillator sections (red) controlled by common IC controller.

Backlight Inverter Power Supply Theory

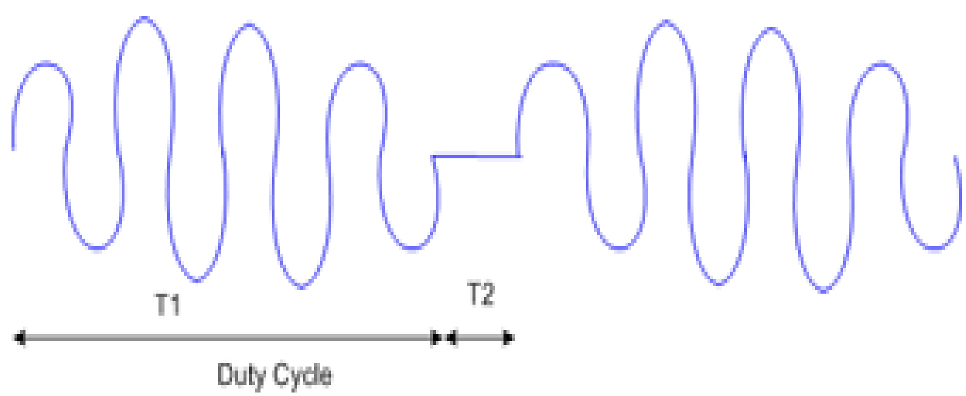
Controlling CCFL Brightness

There are two methods for dimming the CCFL tubes.

1. Analog approach - simply reduces the current through the tubes by reducing voltage to the inverter.
2. Digital method – turn inverter supply output on and off at a chopped frequency rate not visible effectively reducing or increasing the output current. This pulse width modulation method is preferred method as it provides a wider dimming range.



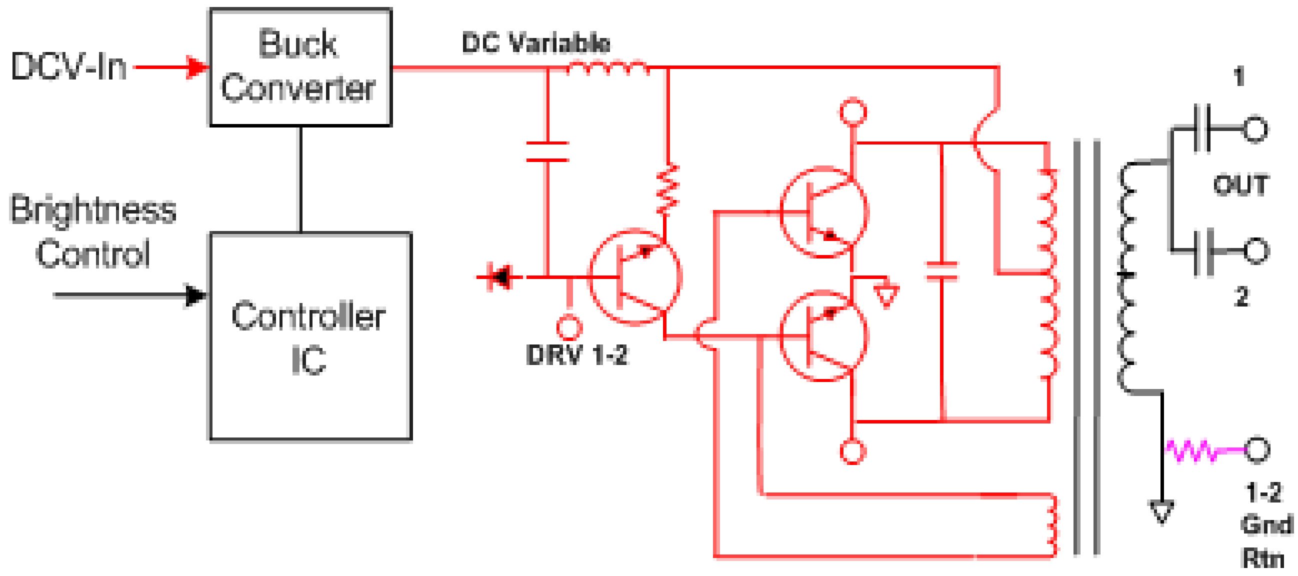
Analog dimming changes the output amplitude and CCFL current



PWM interrupts the output rate at a frequency not visible, effectively changing the output current and CCFL brightness.

Backlight Inverter Power Supply Theory

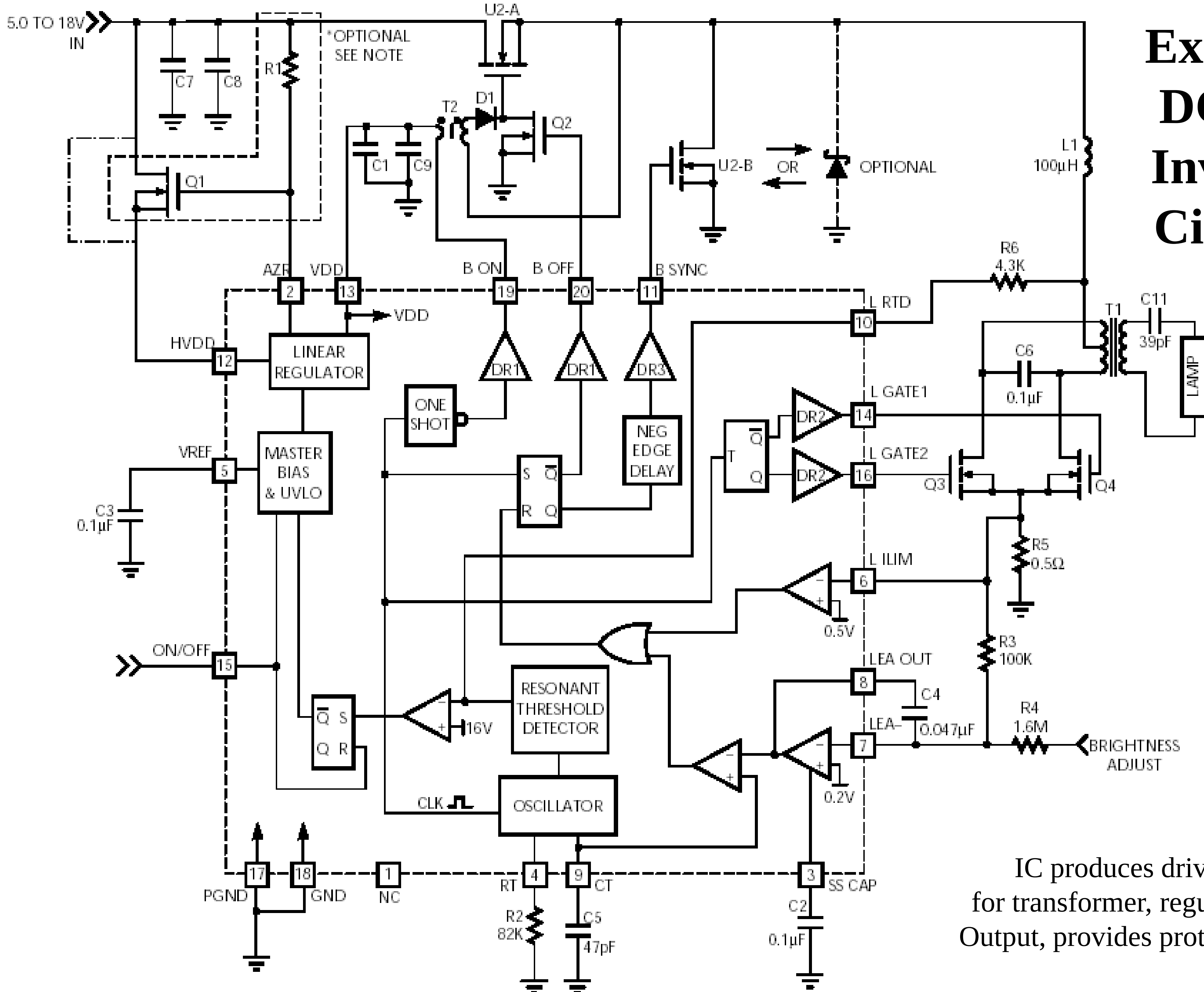
Controlling CCFL Brightness



Analog dimming may use a buck converter to reduce voltage to the oscillator. Reducing the voltage lowers the oscillation level and subsequently the output AC level and bulb current.

A buck converter uses a switching transistor which serves as a gate.
The transistor is switched on and off with a variable duty cycle (PWM) drive signal from a control IC varying the conduction time and output voltage.
An input from the micro (user setting) to the control IC determines the duty-cycle and brightness.

Example DC-AC Inverter Circuits



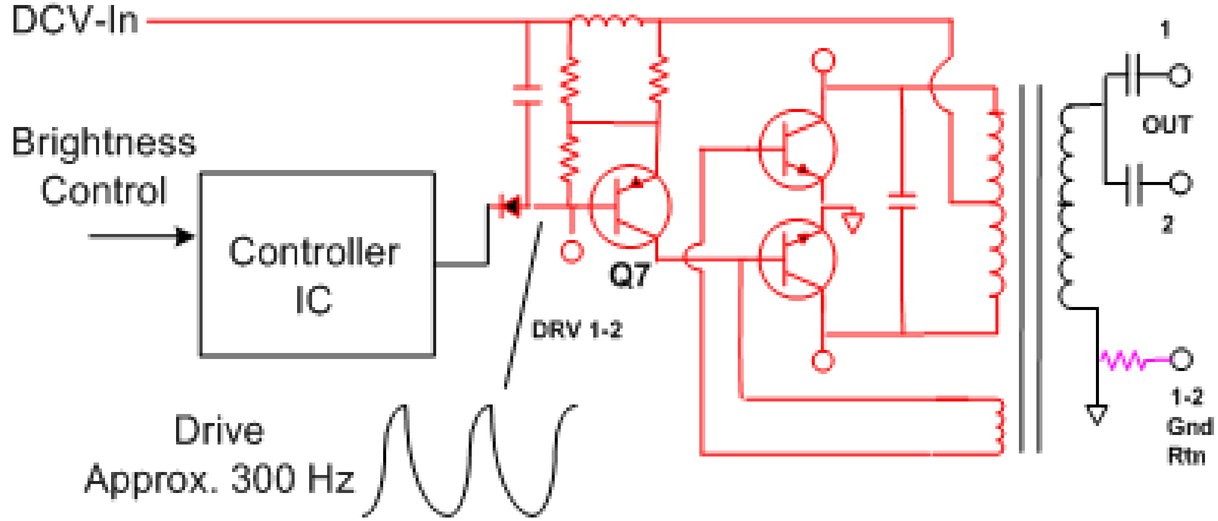
IC produces drive
for transformer, regulates
Output, provides protection

Backlight Inverter Power Supply Theory

* PWM dimming offers more flexibility in controlling brightness and range

* Dimming to 1% is achievable or a 200:1 ratio or better.

PWM describes pulsing the output AC waveform to the CCFL bulbs on and off at a rate that is higher than the human eye can see. The brightness depends on the time the bulb is lit. 100% on time is full brightness while 50% on time is ½ brightness..



Backlight Inverter Power Supply Theory

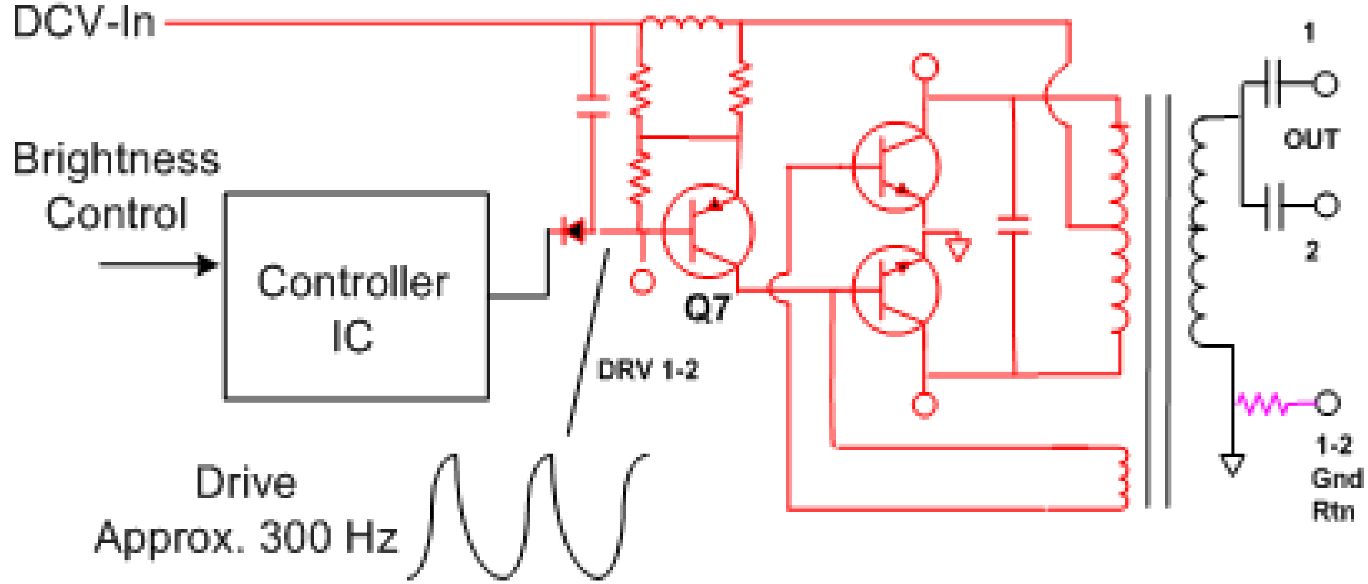
• PWM dimming requires adding a transistor to interrupt the free running royer oscillator.

• Transistor Q7 is added to the circuitry as a control or driver transistor.

• The controller IC applies bias to the transistor to turn the transistor on and off.

• The oscillator is permitted to run normally or be shunted or stopped.

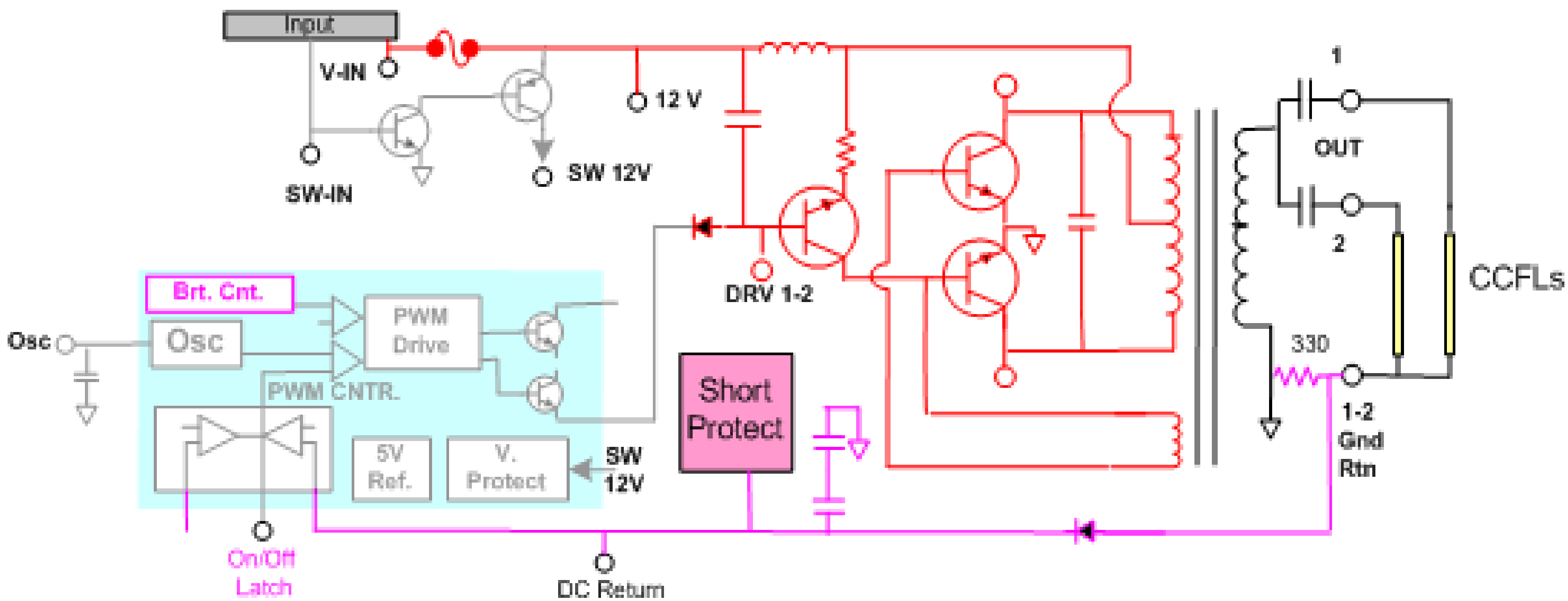
The drive voltage of approx. 300 Hz is increased or decreased in amplitude for min. to max. brightness. The frequency remains stable. The effect varies the duty-cycle of the output CCFL waveform.



CCFL Current Sensing

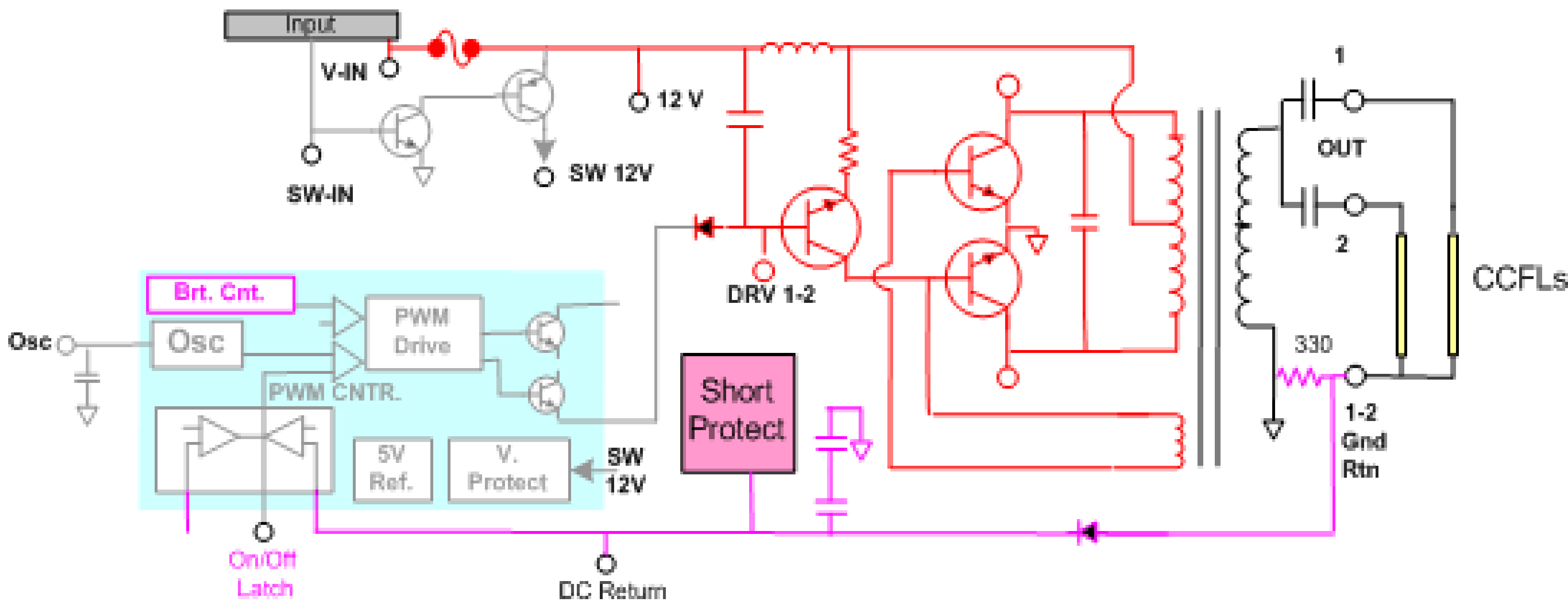
• Backlight inverter power supplies have sensing circuits to monitor CCFL bulb current.
• When the current is reduced substantially from normal the backlight inverter power supply removes its control IC drive output turning off the inverter supply.

• In this manner, the CCFL current sensing circuit disables the inverter output when the CCFL bulbs are open or defective.



CCFL Current Sensing

• The current sensing circuit consists of a sensing resistor and detector/filter.
• CCFL bulb current ireturns to the transformer with a resistor (1-2 Gnd Rtn). 300 ohm
• A combination diode and filter capacitors filter the AC voltage to a DC voltage level.
• The DC voltage is typically several volts during normal operation.
• The DC feedback voltage is applied to a comparator inside the backlight inverter's control IC. *When the CCFL lamp current is normal the detected DC voltage permits the IC to output drive. When CCFL current is reduced, below approx. .5V volt, the detected DC voltage is below a predetermined comparator level and drive output is latched off.*



Troubleshooting Backlight Inverter Power Supply Symptoms

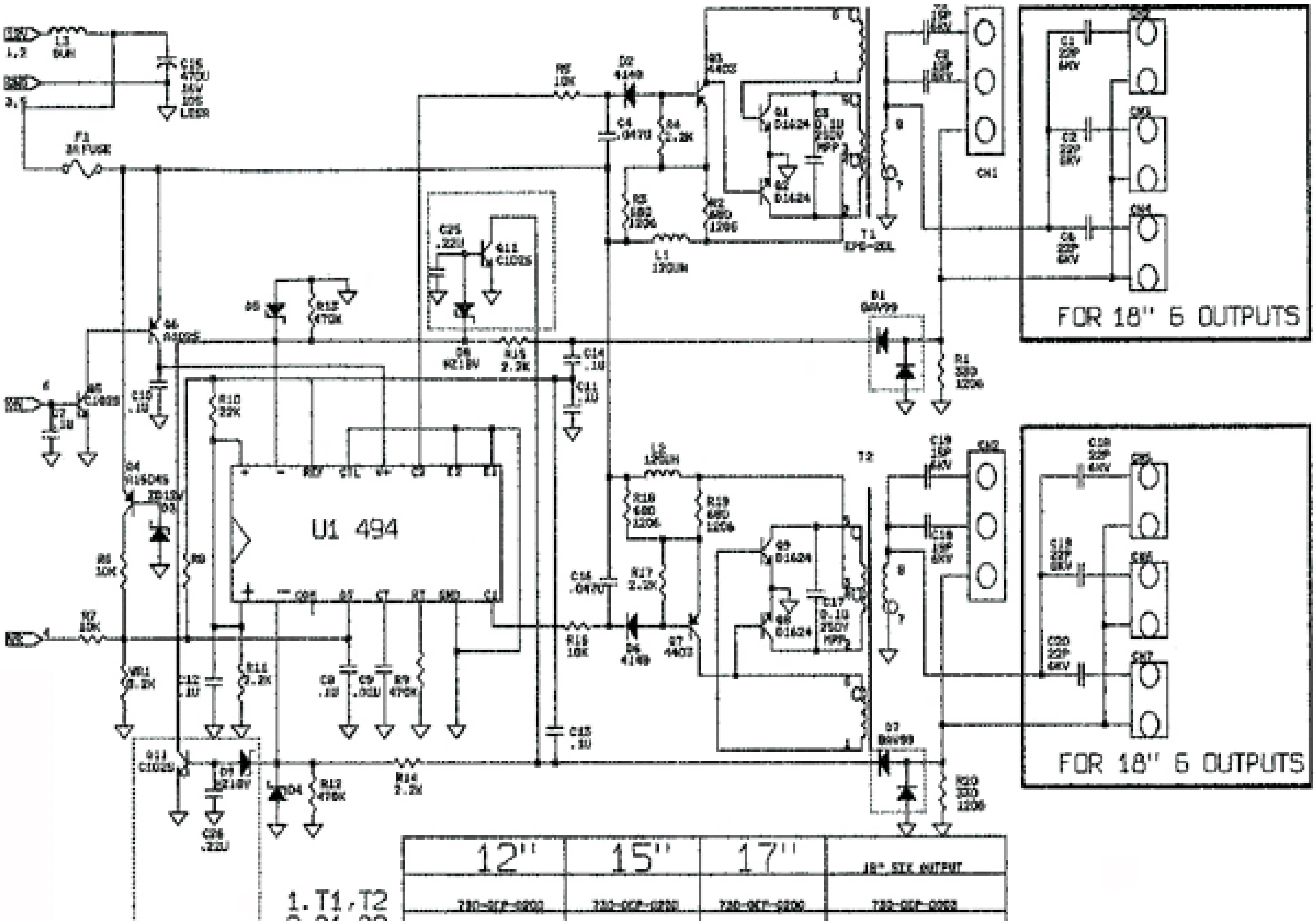
• Backlight inverter power supply problem symptoms are no picture, non-uniform picture brightness, no brightness control and, insufficient brightness range.

• Multiple CCFL bulbs provide light to different LCD areas.

• Multiple sections and outputs in the inverter supply circuits can impact different picture areas.

•Problems may affect the entire picture area or only small portions of the picture.

CCFL or inverter power supply symptoms can impact the entire picture or a small portion of the picture



REMARK:

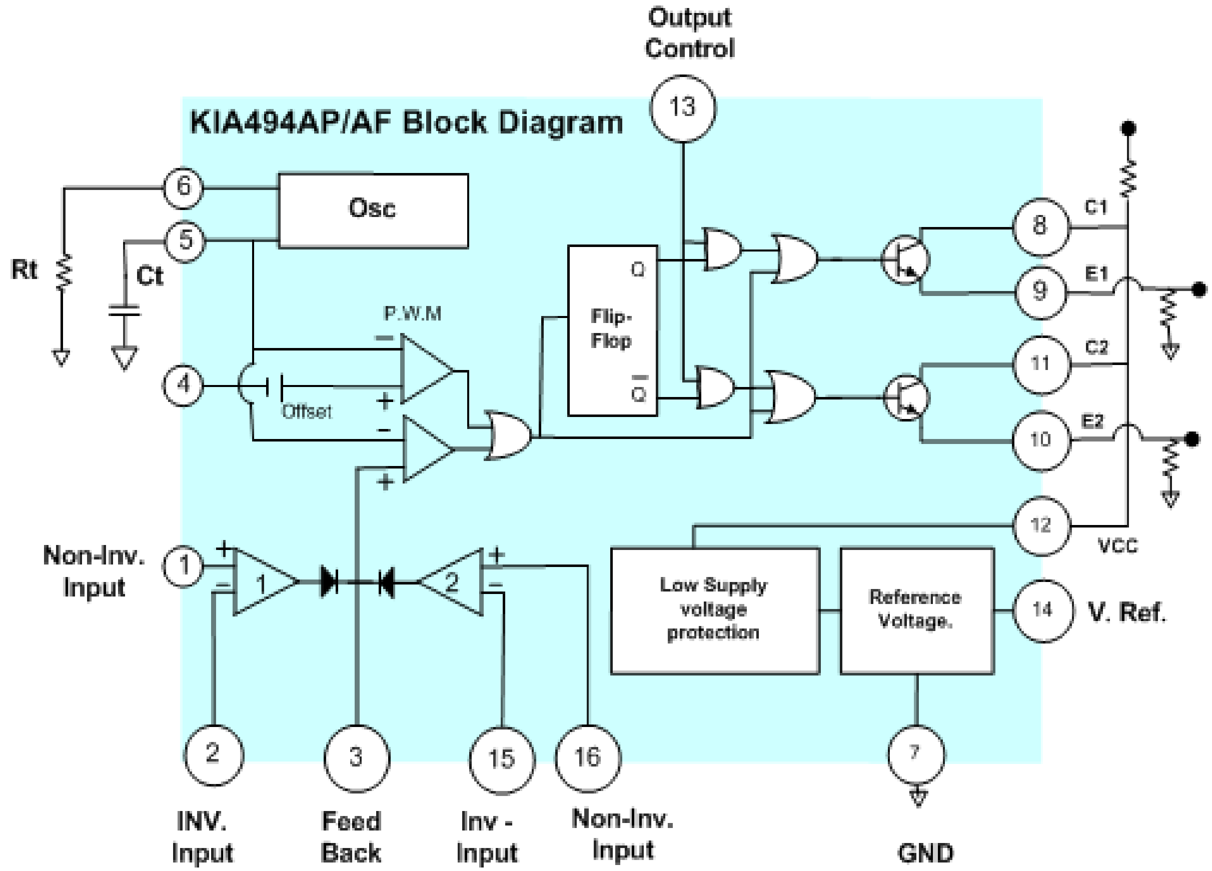
	12"	15"	17"	18" SIX OUTPUT
1. T1,T2	730-0CP-0200	730-0CP-0200	730-0CP-0200	730-0DP-0202
2. Q1,Q2	D1624	D1624	D1624	C5103
Q8,Q9	D1624	D1624	D1624	C5103
3. F1	3A	3A	3A	5A
4. L1,L2	120UH	120UH	120UH	100UH
5. C1,C2 C18,C19	12P/6KV	15P/6KV	18P/6KV	22P/6KV
6. C6,20	12P/6KV	X	X	22P/6KV
7. C17/18	104/250V	104/250V	104/250V	104/250V

Title		
KRISTEL L.P		
Size	Document Number	REV
B	12"/15"/17"/18" INVERTER	B
Date: September 9, 2003	Sheet	of

KIA494 Control IC

The KIA494 IC provides PS control and brightness control. It contains two error amplifiers, an on-chip adjustable oscillator, dead-time control (DTC) comparator, a pulse-steering control flip-flop, a 5V precision regulator, and output control circuits

.



• VCC supplied to pin 12 feeds a reference 5V regulator. The regulator outputs 5 volts to pin 14.

• A low supply voltage protect circuit disables the 5V regulator when the VCC input falls below 7 volts.

• The IC oscillator produces drive to the internal error amplifiers.

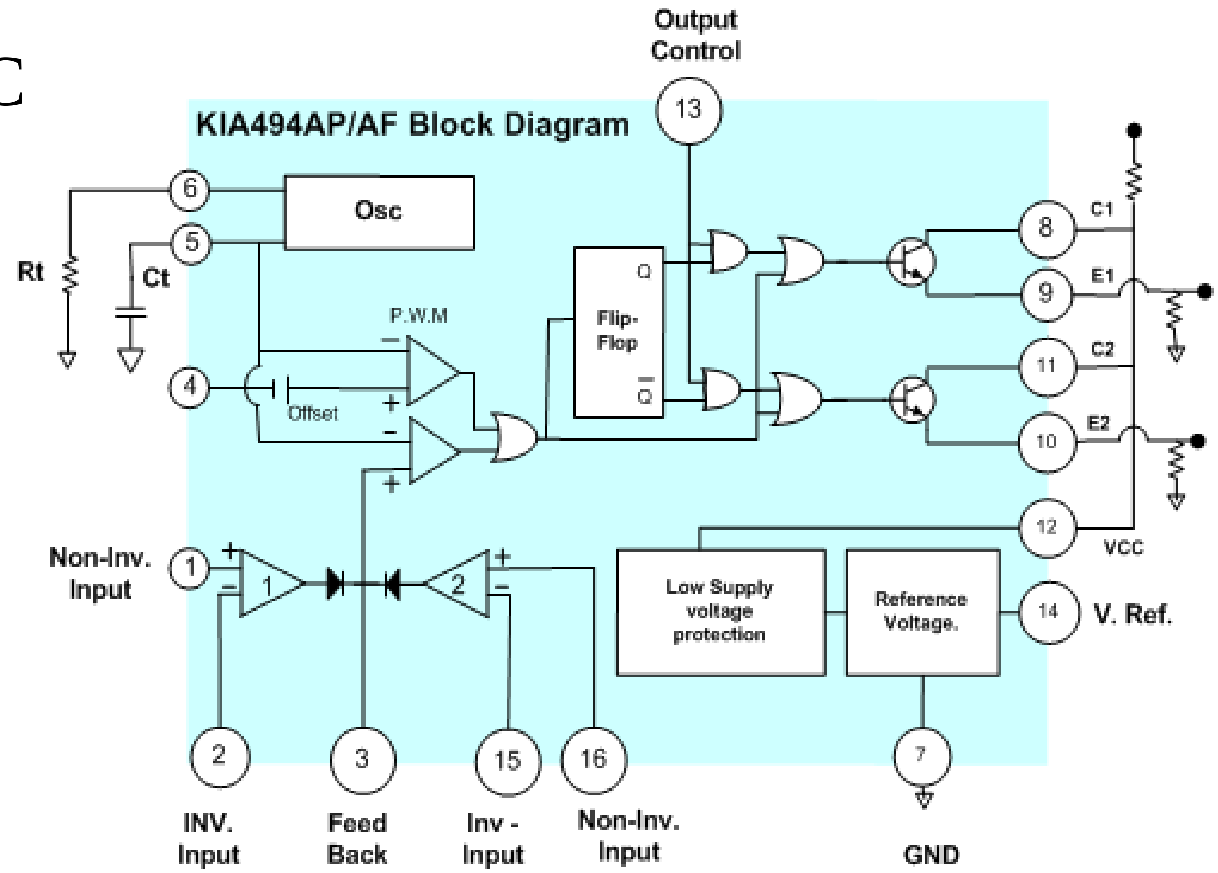
•The oscillator frequency depends on an external resistor (pin 6) and capacitor (pin 5).

• A dead-time control input (pin 4) to a comparator op-amp provides a fixed offset - 5% dead time.

•

• This input is used for brightness control duty-cycle control.

KIA494 Control IC

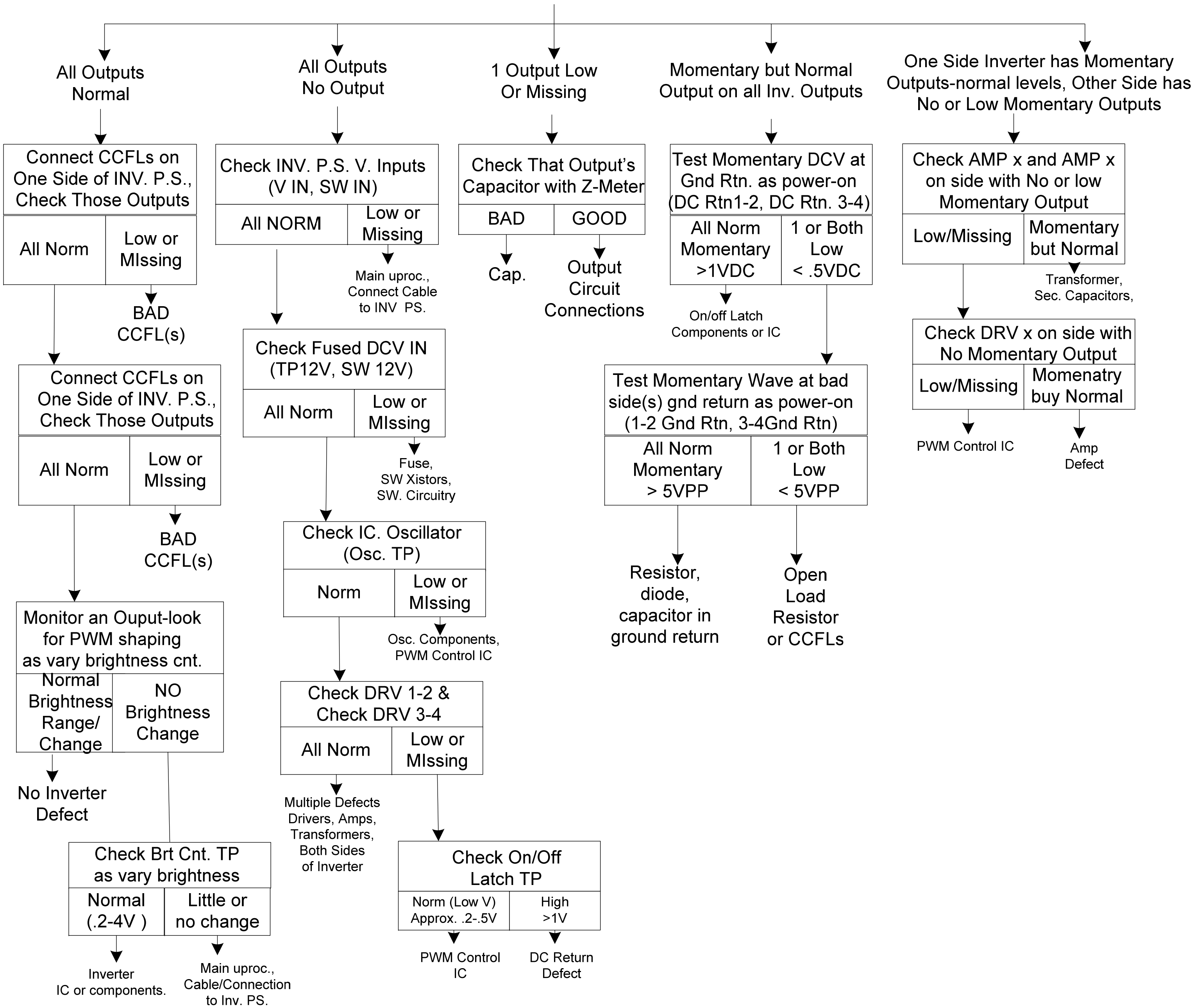


In the Sencore LCD color trainer the collector outputs C1 and C2 output drive to the driver transistor bases. E2 and E1 are tied to ground as is pin 13. C1 is pulled to positive supply voltage through R18, R17, D6 and R16. The IC transistor turning on reduces the voltage at C1 terminal and at the base of Q7 biasing on Q7. Similar action occurs on output C2.

Comparator op-amps 1 and 2 internal to the KIA494 serve as protection control for the inverter supply. A resistor divider from the 5V ref. output (pin14) through R10 and R11 set up a threshold voltage at the + inputs (pins 1, 16). Since the resistance of R11 is 1/10 of the resistance of R10, there is about .5V at these pins. Current sensing in the CCFL ground return applies voltage to the – inputs at pin 2 and pin 15. As long as the input voltage exceeds .5volts the op-amps keeps pin 3 low and the PWM internal op-amps permit the oscillator drive to output from the IC. If the voltage to pin 2 or 15 drops below .5 volts the output goes high (pin 3) defeating the output from the IC at pins 8 and 11 stopping operation of the inverter supply.

BACKLIGHT INVERTER POWER SUPPLY TROUBLESHOOTING FLOWCHART

Unplug all CCFLs, 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 Ouput 2 etc.



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

All Outputs Normal

All Outputs No Output

1 Output Low Or Missing

Momentary but Normal Output on all Inv. Outputs

One Side Inverter has Momentary Outputs-normal levels, Other Side has No or Low Momentary Outputs

<u>Inverter power supply symptoms can be typically broken down into the following categories:</u>

1. All Outputs Normal:
2. All Outputs Dead (no output):
3. One Output Low or Missing – Others Normal:
4. All Outputs - Momentary Output
5. Momentary Normal Output one Inverter Side – Other Side No or Low Momentary Output:

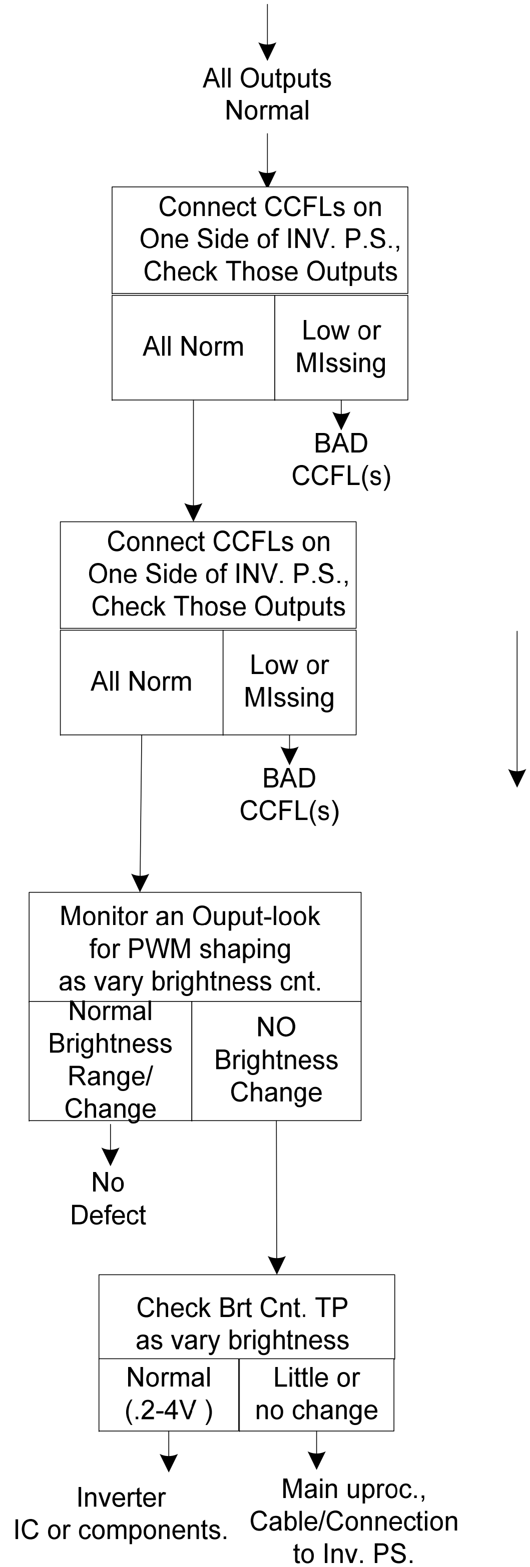
Troubleshooting Backlight Inverter Power Supply

If all outputs show normal on the SC3100 with resistive loads,k the backlight inverter supply is working.

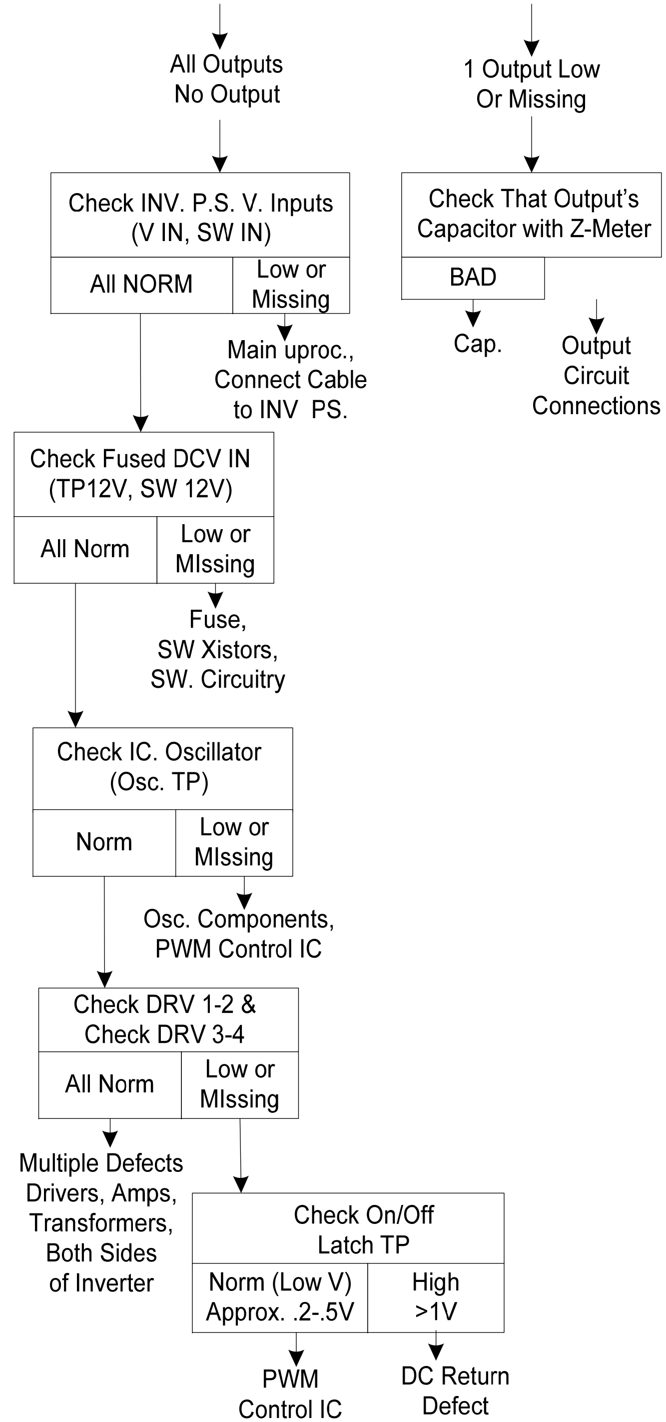
If the display exhibits inverter or CCFL symptoms reconnect the CCFL bulbs on one side of the inverter and then the other checking for normal output from the inverter with the SC3100. A problem when connecting CCFL bulbs indicate multiple bad or a shorted CCFL bulb which is shutting down the inverter.

If the inverter outputs with the bulbs connected increment the brightness control through its range and monitor the output for PWM shaping by viewing the SC3100 waveform. Normal output and brightness control indicate the backlight supply is working.

If the brightness control is not varying the brightness or causing a PWM shaping of the output waveform, test the brightness control input voltage to the inverter input. If it ranges normally, the brightness control circuit of the backlight inverter is defective. If the voltage does not change normally, the microprocessor control or cabling to the inverter is defective.



Troubleshooting Backlight Inverter Power Supply



<u>All Outputs Dead (no output):</u>

If all the outputs are missing, it is likely that the backlight inverter is missing an input or has a defect in the controller IC common to both output sides. Check the input DC voltage, switch input voltage and brightness control input voltage to the inverter board. If any or all are missing or abnormal the microprocessor/control circuit board or cabling from this circuit board is bad. If all inputs are normal check the DC voltage after the fuse(s). If the voltage is low or missing, the fuse is open. If normal, check the voltage, IC oscillator, and drive outputs from the IC as an IC or IC component is likely defective.

<u>One Output Low or Missing – Others Normal:</u>

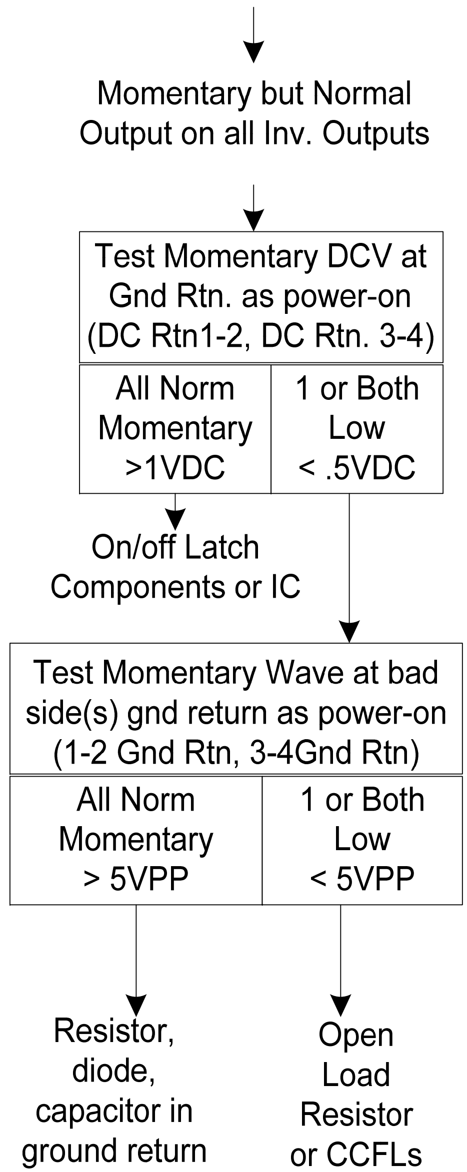
This is an unusual symptom as multiple outputs on one side of the inverter share the controller IC, driver, royer oscillator and transformer. Double check the output to be sure. If one output is bad, the problem must be with the series output capacitor, connector or circuit connections to that output.

Troubleshooting Backlight Inverter Power Supply

<u>All Outputs - Momentary Output</u>

Momentary output(s) is common among backlight inverter symptoms but not to all outputs. A momentary output to all outputs with proper resistive substitute loads suggest the control IC, drivers, royer oscillators, transformers, series output capacitors are all good. The problem is likely a protection shutdown that is unwarranted. The likely cause is a problem in one of the current sense feedbacks or in an over-voltage shutdown protect circuits.

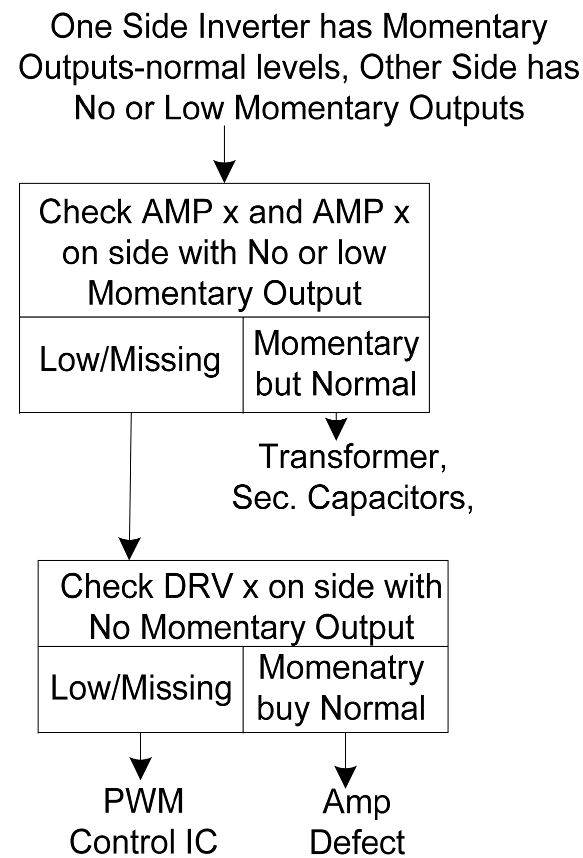
Troubleshooting this defect requires measuring the momentary voltages as you turn on the display and output is present for that brief moment. Measure the DC voltage on the DC return test points. Normal voltage suggests a defect in the comparator amplifier section of the control IC or related components. The voltage should rise up to several volts while the output waveform is present. If not, a defect exists in the ground return resistor, diodes, or filter capacitors preventing DC voltage feedback an indication of normal CCFL current flow. Measure for a waveform at the ground return point of the CCFL bulbs to determine where the open is in the DC feedback path.
isolate the defect.



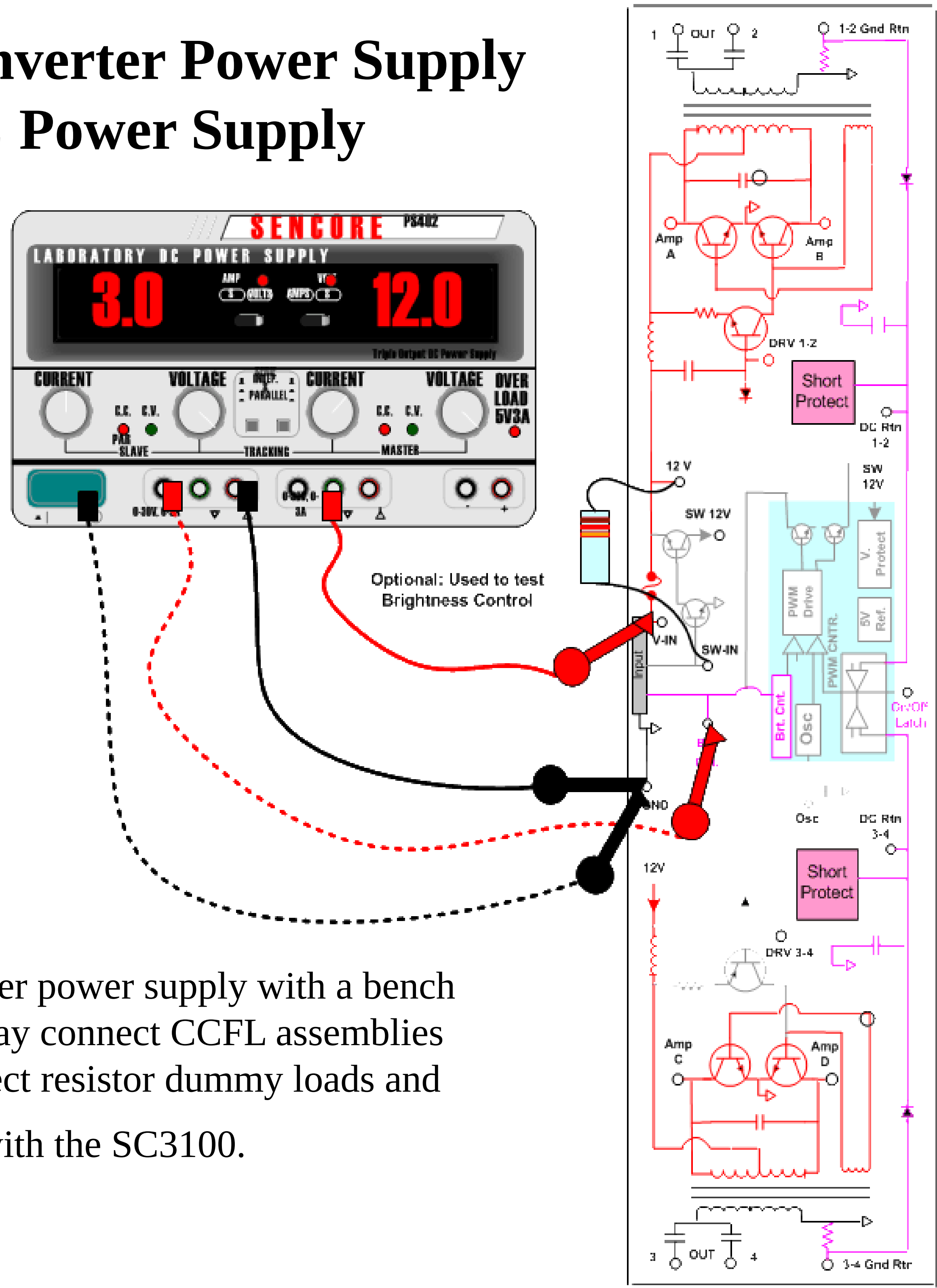
Troubleshooting Backlight Inverter Power Supply

<u>Momentary Normal Output One Inverter Side – Other Side No or Low Momentary Output:</u>

An output from one inverter side and not the other is a common symptom. It indicates that a problem exist in the driver, royer oscillator or, transformer on that side of the backlight inverter. Measurements must be made by repeatedly applying voltage to the inverter while you measure momentary waveforms or voltages. Check for the normal waveform at the AMP test points to see if the oscillator is starting and oscillating. A normal momentary waveform indicates a bad transformer or secondary capacitor or connector. No waveform indicates an oscillator defect, driver stage defect or bad IC output. Measure for a momentary waveform at the driver transistor to further isolate the defect.

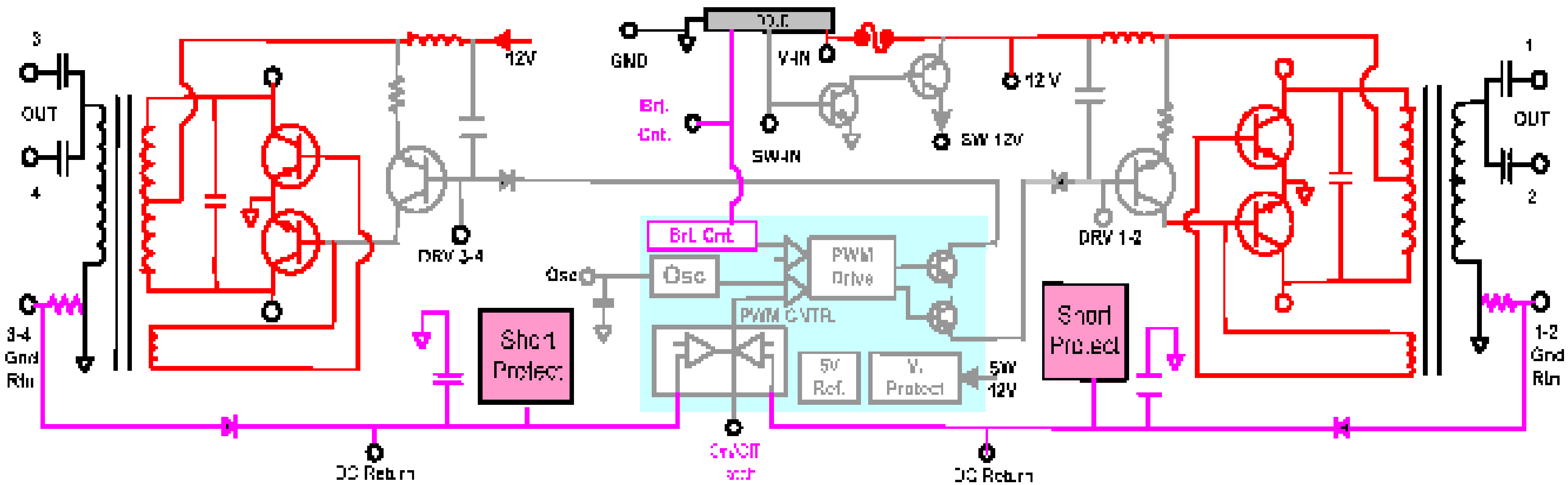


Powering/Testing the Inverter Power Supply with a Bench DC Power Supply



You can power the backlight inverter power supply with a bench DC power supply to test it. You may connect CCFL assemblies to indicate normal output or connect resistor dummy loads and monitor the voltage with the SC3100.

Backlight Inverter Power Supply Quick Trouble Shooting



By *Ray Holdren*,

- Previous Service Mgr / ***Kristel Nevada***
- Instructor / ***Sencore***
- Associate Professor / ***College of Southern Nevada***, Cheyenne Campus

Quick Inverter Troubleshooting

1. First Check V-In Voltage and then check on the other side of the Fuse to Verify that there's voltage to the Inverter.

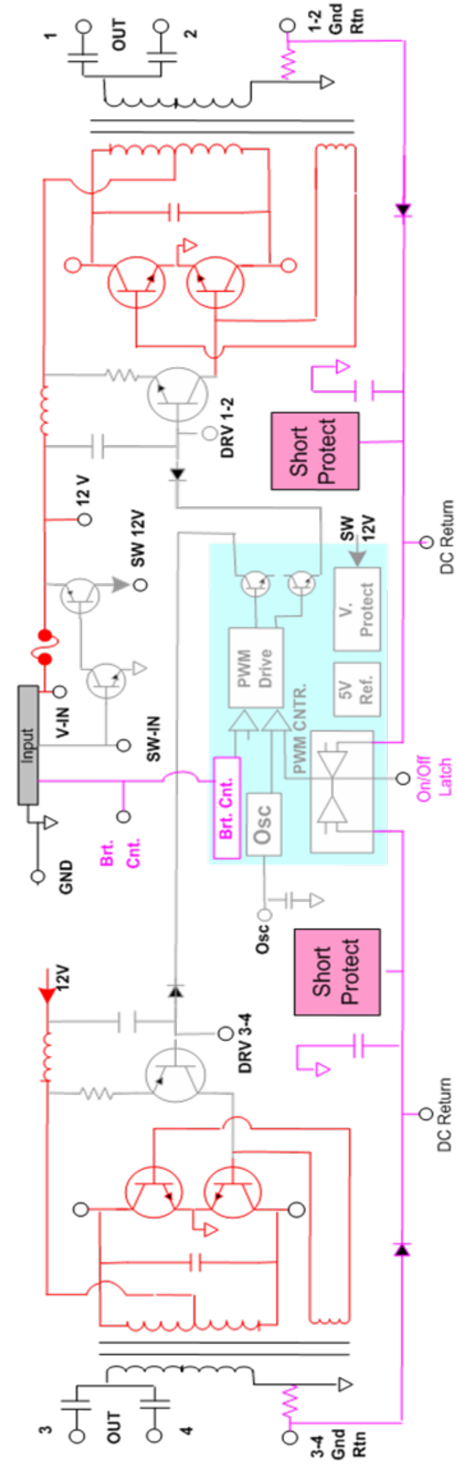
2. Test Switched – In or Enable Voltage.
Make certain that the Microprocessor has turned on the device. If not, then recheck the Micro Processor or Cables for Defects or missing signals.

3. Test the Switched Input Voltage and verify the Switching Device is working.

4. Test the Oscillator on the Control IC. Verify that the Chip is working. If it's working, go to step 6. If not, go to
step 5.

5. Test the Latch Voltage to see if the IC is in a Latched Out Condition. This can happen for two reasons: (1.) There is only One side of the inverter working. (2.) The Inverter is in a Short Circuit Shut Down Condition.

6. If the Oscillator is OK, Test the Driver Transistors to see if they have an Input from the IC.Then Check their Outputs. If there are no Inputs, the IC is Bad. If there are no outputs, change the Driver Transistors. If there are Outputs, go to step 7.



Quick Inverter Troubleshooting

7. **Check the Outputs of the Oscillator Amplifier Transistors. If there's no Output, the Amplifier Transistors should be replaced. If they're OK, go to step 8 (note: Change Both Transistors if one is found Bad)**

8. **Test the Transformers Primary & Secondary for Open or Shorted Windings. Replace if Necessary**

9. **If the Transformer's are Good, Test the Output Capacitors and Replace any defective ones you find.**

10. **Next, Test the Cold Cathode Fluorescent Lamps (CCFL's). Substitute the lamps with a Load Resistor(s) (equal to the impedance of the lamps) to verify that the Inverter is working properly. Then you can test the Lamps with a known good inverter to Verify if they're working or not. You must use an Inverter, you can not test them with a Meter. Replace any Defective CCFL's that maybe Shorted or Burned Out.**

11. **The last step would be to Burn-Test the Inverter and the Lamps to make sure your repairs are correct. Only Burn-Test while you are present. In case there are any Danger of Shock Hazards that might happen.**