Converting a 27 inch 2011 iMac to a Standalone 2K Display

The details below document how I was able to use both the original iMac power supply and the original iMac inverter board for my conversion. **This completely eliminated the brightness issues** of the constant current boards that are commonly supplied with the LCD driver boards for these screens. The key was to learn how the iMac power supply and the inverter board work. Essentially, we are trying to replicate how the power supply, inverter board, and the main logic board function in the iMac and then figuring out how to preserve the functionality of the power supply and inverter board *without* the main logic board present.

Note: Using the components below will require some soldering in some cases, but it is not complex.

- *My soldering skills are not good*, but I found them to be adequate for the amount of soldering for this conversion
- It is important to have a soldering iron with a skinny tip to connect the wires to the PWM signal generator and the audio amplifier board
- It may be possible to do this conversion without soldering, but you will need to find some different components than some of those that I used (e.g., using wire nuts or screw type wire connectors on PCBs)

Original iMac Specs

- 2011 27 inch iMac with i7-2600 CPU
- 32 GB RAM
- AMD WX7100 graphics card with 8GB
- 1 TB SSD, 750 GB and 320 GB HDD
- Using OpenCore to support running MacOS versions beyond High Sierra

My Plan – Convert the iMac to a standalone display while also keeping the following pre-conversion internal components in place:

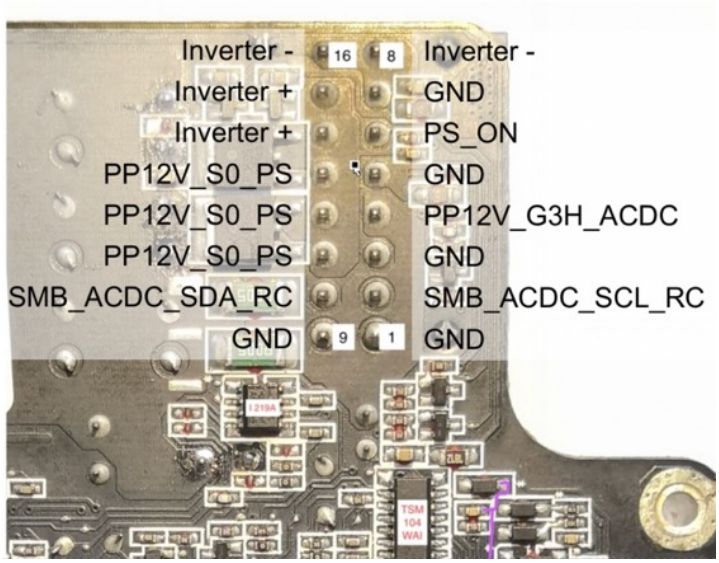
- Power supply
- Inverter board
- Speakers
- 2x 2.5" HDD (I am using the SSD for other purposes)
- Superdrive

Additional Parts

- LCD driver board – the main sources for these are eBay and AliExpress and are specific to your display model (this will likely come with a constant current board which will no longer be used)
- Latching pushbutton (to turn the display and power supply on/off – I did not connect the LED leads)
- Momentary pushbuttons (to control brightness via the PWM board instead of using software)
- Step down voltage converters
- PWM signal generator
- Audio amplifier board (the LCD driver board amp was too weak to drive the iMac speakers)
- Crossover boards (these are probably overkill given their 400W rating, but they were not expensive and the wiring connectors are easy)
- MOSFET Driver board (this is needed to restore display sleep functionality)
- Wire and JST connector for the MOSFET board (3-wire for power and control signal)
- Small fan for inverter cooling and a temperature controlled fan PWM (This PWM can control 2 fans independently)
- A suitable USB 3.X hub (I already had one of these that I didn't use very often)
- SATA to USB 3.0 hard drive adapters (make sure the USB connector style is same as the hub)
- Slimline SATA to USB 3.0 adapter for the SuperDrive (make sure the USB connector style is same as the hub)
- Power connectors to connect the power supply to the LCD driver board (ensure you get the right internal size for your board – 2.1 mm or 2.5 mm)

Figuring Out the Power Supply and Control Signal paths

Understanding the iMac power supply unit



1. The iMac power supply uses a 16 pin MOLEX connector to connect it to the inverter board and the main logic board. ENSURE YOU KEEP THIS CONNECTOR INTACT!

2. Until it is commanded to turn on, all the pins *except Pin 4 and Pin 6* of the power supply remain de-energized when plugged into the wall outlet. Pin 4 (PP12V_G3H_ACDC) always has 12Vdc available anytime the unit is plugged in (see Pin 4 details below).

3. To command the power supply to turn on, Pin 6 (PS_ON) must be triggered by shorting it to ground. *The existing iMac power button will not work for this* since it is a momentary pushbutton instead of a latching pushbutton (the iMac main logic board keeps the PS_ON triggered via electronic means that are not available on the LCD driver board). For my conversion, I connected Pin 6 to Pin 7 (GND) with a latching pushbutton connected to their wires coming from the 16 pin MOLEX connector. This provides a way to directly energize the power supply, the display, and the internal components and does not require connecting the existing iMac power button to the LCD driver board control strip.

4. The table below shows the expected readings from the power supply for when the PS_ON pin is triggered and not triggered. When the power supply gets triggered by shorting pin 6 to GND, you get three additional 12Vdc power lines from pins 11, 12, and 13 to use for the internal components of your conversion. I used these lines exclusively for power to the LCD driver board and the other components. *I did not use pin 4 for anything since I did not want any of the internal components to be powered all the time just because the cord is plugged into the wall outlet*.

PS_ON triggered / not triggered (all values are Vdc)

Pin 1 (GND)	**0 / 0**	Pin9 (GND)	**0 / 0**
Pin 2 (SMB_ACDC_SCL_RC)	**~2.9 / ?**	Pin 10 (SMB_ACDC_SDA_RC)	**~2.6 / ?**
Pin 3 (GND)	**0 / 0**	Pin 11 (PP12V_S0_PS)	**12 / 0**
Pin 4 (PP12V_G3H_ACDC)	**12 / 12**	Pin 12 (PP12V_S0_PS)	**12 / 0**
Pin 5 (GND)	**0 / 0**	Pin 13 (PP12V_S0_PS)	**12 / 0**
Pin 6 (PS_ON)	**0 / ~4**	Pin 14 (Inverter +)	**12 / 0**
Pin 7 (GND)	**0 / 0**	Pin 15 (Inverter +)	**12 / 0**

Pin 8 (Inverter -)	**0 / 0**	Pin 16 (Inverter -)	**0 / 0**

? = I did not measure these two when PS_ON was not triggered

Power supply pin functional descriptions
GND = Ground (pins 1,3,5,7,9)

PP12V_G3H_ACDC = Always on Standby Power for some of the system management controller functions (pin4). For example (not an all inclusive list):

- Standby mode function of the Bluetooth controller to support waking the system up from sleep using the Bluetooth keyboard or mouse
- Wake On LAN functionality of the ethernet port
- *12Vdc from this connection is present anytime the computer is plugged in to the wall outlet*

PS_ON = Power Supply On (pin 6).

- The power supply remains off unless it gets triggered to turn on.
- Normally, the PS_ON port would get triggered by the iMac motherboard to energize the power supply when the power button is pressed.
    - In order to use the inverter, a new method to trigger the power supply to come on is required.
    - I used a latching push button like this – pushbutton – to connect PS_ON (Pin 6) to GND (Pin 7).
    - The PS_ON port must remain triggered for the power supply to maintain its energized state, therefore it requires a latching push button, not a momentary push button

PP12V_S0_PS = the 3 main power leads for all the computer components (motherboard, video card, drives, etc.) except for power to the display and standby power (pins 11,12,13)

- Only energized when the PS_ON is tripped

SMB_ACDC_SCL_RC and SMB_ACDC_SDA_RC = Power for the system management bus controls and clock functions (pins 2,10)

- SDA stands for Serial Data. SDA lines are used to carry the actual data bits being communicated between the computer components/peripherals
- SCL stands for Serial Clock. The SCL line generates the clock signal that ensures all components/peripherals remain synchronized in their communication

Inverter +/- = Power to the LCD inverter board and ultimately the LCD backlight (pins 8,14,15,16)

- Only energized when the PS_ON is tripped
- The "Inverter –" pins are simply ground pins for the inverter board to connect back to system ground

5. It is easiest to use the existing wiring harness that connects the power supply to the inverter and the main logic board in the iMac.

- The wires that would normally connect to the main logic board will be used to supply power to the LCD driver board and other internal components
- Carefully cut away the sleeve that bundles the wires from the power supply to the 14 pin logic board connector. This is necessary so you can easily determine which wires connect to the pins at the power supply connector and the inverter connector.
- Cut all the wires where they connect to the 14 pin main logic board connector since it will not be used **(NOTE: Do NOT cut the wires at the power supply connector [16 pins] or the inverter board connector [6 pins]!!)**
- Trace the wires to power supply pins and mark them for easy future reference using tape or another simple marking method
    - The wires from pins 11, 12, 13 (and a couple of the GND pins) will be your main power source for the LCD driver board and any other internal components
    - The wires from pins 6 and 7 will be used for the PS_ON pushbutton described in paragraph 3 above

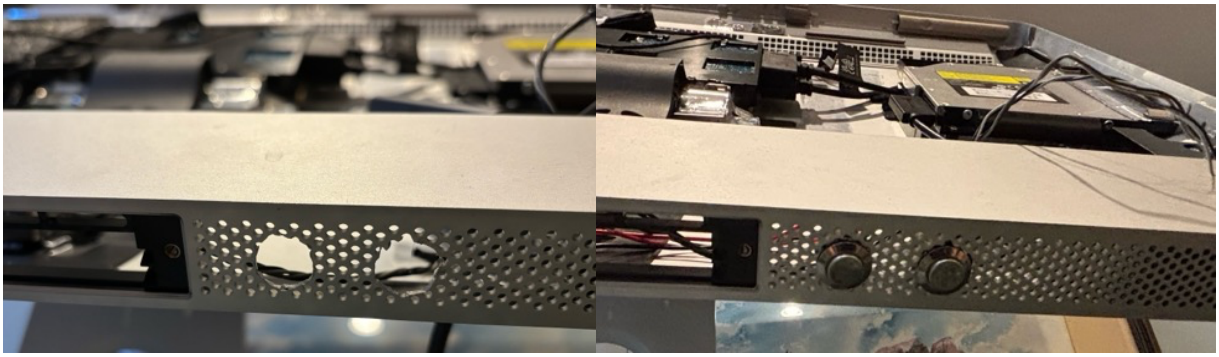
- Find the two small wires that run between the logic board connector and the inverter board (i.e., two wires will bypass the power supply connector) – these are your BL_ON (or ENA) and PWM wires!

Power pushbutton installation

1. Use an appropriately sized drill bit (12mm for the pushbutton I used) to drill a hole in a convenient place on the iMac case for the button location
    - I put my button on the bottom of the case to the left of the RAM access cover (see picture below). Ensure your drill bit is centered before drilling as the fit for the button in this location is a bit tight
2. I recommend having most/all of the internal components removed before you drill your hole to prevent metal shavings from getting into your power supply or inverter board as you drill
3. Clear the hole of drill shavings or burs and insert the pushbutton
4. Connect the pushbutton wires to the wires for pin 6 and pin 7 of the power supply
5. Conduct a test by checking for 12Vdc at the wires from pins 11,12, and 13. (*NOTE: Ensure you have the cut ends of all the loose power supply wires properly insulated and away from metal before you test the pushbutton functionality*)

Brightness control pushbuttons (Only required if you do not desire to use software methods to control display brightness)

1. Prepare the PWM signal generator board for future installation and connection to the pushbuttons. A total of four wires will need to be soldered to the PWM board's duty cycle buttons - two wires each to the increase and decrease duty cycle buttons
2. Use an appropriately sized drill bit (12mm for the pushbuttons I used) to drill two holes in a convenient place on the iMac case for the button location
    - I put my buttons on the bottom of the case to the right of the power pushbutton and to the left of the RAM access cover (see the picture below). Ensure your drill bit is centered before drilling as the fit for the button in this location is a bit tight
3. I recommend having most/all of the internal components removed before you drill your hole to prevent metal shavings from getting into your power supply or inverter board as you drill
4. Clear the holes of drill shavings or burs and insert the pushbuttons to ensure proper fit. Do not connect them to the PWM board yet as there is more to solder to it later on.



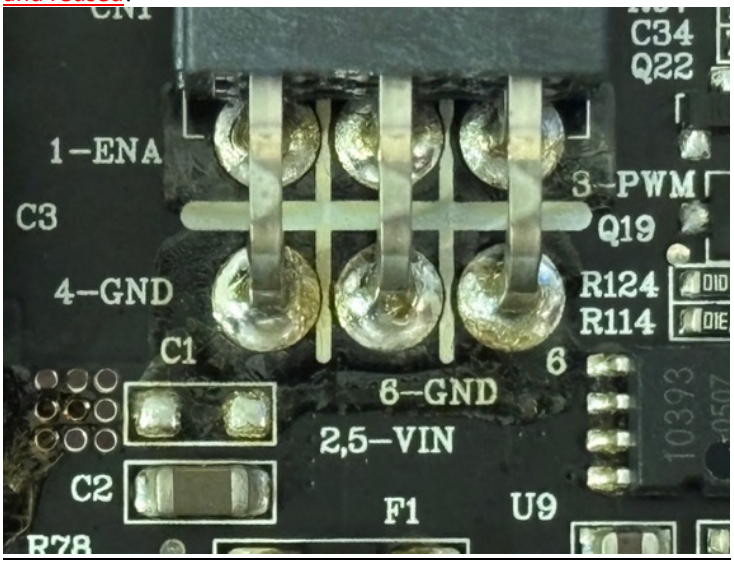
Power to LCD driver board

1. Connect one of the 12Vdc power wires (pin 11, 12, or 13) and a GND wire to one of the 'power connectors' (see "additional parts" section above)
2. Plug it into the LCD driver board
3. Push the power button installed above and verify the LDC driver board gets power – you should see an LED on the LCD controller board turn on (it will be green or red in color)

Insert pic here….

Connecting the LCD driver board to the iMac inverter board through the voltage step down board, the logic level inverter, and the PWM signal generator

1. Understanding the iMac Inverter board and its connector – This 6 pin MOLEX connector will be left fully intact and reused!



Pin 1 (ENA)	**3.3 (4.94)**	Pin 4 (GND)	**0**
Pin 2 (VIN)	**12**	Pin 5 (VIN)	**12**
Pin 3 (PWM)	**3.3 (3.06)**	Pin 6 (GND)	**0**
Pin 3 PWM Frequency	**13.3kHz (36.03)**		

***All values above are Vdc except for the PWM Frequency (kHz)

The values in the table above are from 3 sources:

- Pins 2, 4, 5, 6 are coming from the iMac Power supply (the "Inverter +" and "Inverter –" signals)

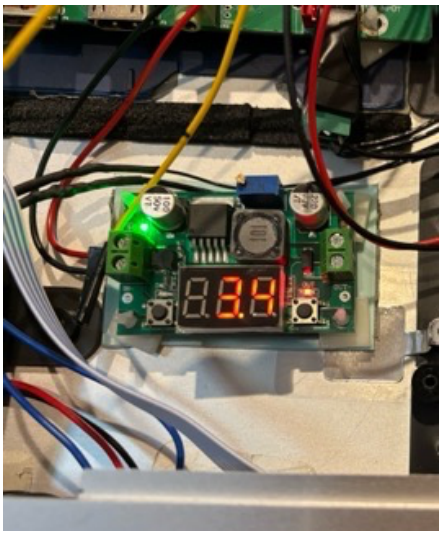
- The **red** values in parentheses for Pins 1 and 3 are the readings fed from the LCD driver board I purchased for my conversion.
  - Pin 1 (ENA) is coming from the BLO terminal on the LCD driver board
  - Pin 3 (PWM) is coming from the ADJ terminal on the LCD driver board

However, when connecting these to the iMac inverter, it always resulted in a black screen. Additional online research indicated that my inverter required different voltages and frequency values than those provided by the LCD driver board. There are lots of different sources of info for these with lots of different answers. Ultimately, I was able to find the schematics for the iMac Main Logic Board and confirmed the required values were 3.3Vdc and 13.3 kHz.

- The **black** values for Pins 1 and 3 in the table are the **required** voltage and frequency values specified in the schematics.
  - We will use these values to set the outputs of the dedicated voltage converters and the PWM board we will install inside the iMac case.

2. Connect the LCD driver board to the two voltage step down boards. To do this, we will be using the small 6 pin wiring harness that attaches the constant current board to the LCD driver board. (Note: This is NOT the 6 pin MOLEX connector to the iMac inverter!!)

- Cut the 12Vdc wires and the GND wires in this 6 pin wiring harness. For my LCD board, these wires were red and black. Judge your cut location based off your planned layout for the boards in the iMac case so that these wires will be able to reach their destinations without any need for extensions.
- Feed one 12 Vdc wire and one GND wire to the appropriate input terminals on one of the voltage step down boards
- Turn the power one and set the board to step down the **12Vdc input to a 3.3Vdc output** using the buttons on the board
- NOTE: *Use a multimeter to measure the voltage output* of the step down converters to ensure the LCD display is accurate. My board indicated about 0.07Vdc higher than actual voltage.
- NOTE: It may require many turns on the step down potentiometer on the board before the voltage begins to drop. This is normal.



3. Connect the voltage step down board and the LCD Driver board BLO signal line to the MOSFET Driver board.

- Attach two wires to **the 12V to 3.3V step down converter output** terminals
- Connect these wires to the power wires of the 3-wire JST connector
- Cut the BLO wire on the 6 pin wiring harness for the LCD driver board. This was a yellow wire between the red and black wires for my LCD board wire harness
- Connect the BLO wire from the LCD driver board to the signal wire of the 3-wire JST connector

Insert pic here…

4. Connect the MOSFET Driver board to the iMac inverter board. **This will allow the BLO signal from the LCD Driver board to control the MOSFET Driver board to send the 3.3Vdc signal to the ENA terminal on the iMac inverter board in order to maintain display sleep functionality of the LCD driver board (the 3.3Vdc signal will be turned on and off by the BLO signal coming from the LCD Driver board)**

- Insert the iMac inverter ENA wire (pin 1 of the inverter board) into the '+' terminal on the MOSFET Driver board output connector.

- Connect another wire to the '-' terminal on the MOSFET Driver board output connector and connect the other end of this wire to a GND connection.

Insert pic here…

5. Connect the voltage step down converter (12V to 3.3V) to the PWM signal generator
- Attach two additional wires to the **12V to 3.3V step down converter output** terminals
- Solder the other ends of these wires to the PWM board input terminals
- Solder the PWM wire connected to pin 3 on the iMac inverter MOLEX connector to the duty cycle output terminal of your choice
- Turn on the power and set the PWM frequency to 13.3 kHz and the duty cycle of your desired port to 100% (Note: The duty cycle may require adjustment later to tailor the brightness level to your taste)
- NOTE: *Use a multimeter to measure the voltage and frequency output* of the PWM board to ensure the signal is correct. You should get 13.3 kHz and 3.3Vdc. The voltage value will reduce in proportion to the selected duty cycle setting (e.g., 75% duty cycle will read 0.75x3.3 = 2.48 Vdc).
- I set my duty cycle to 75% as the starting value before I reinstalled my display.
- Connect the PWM board duty cycle buttons to the brightness control pushbuttons if you are using that method to control display brightness.

Insert pic here…

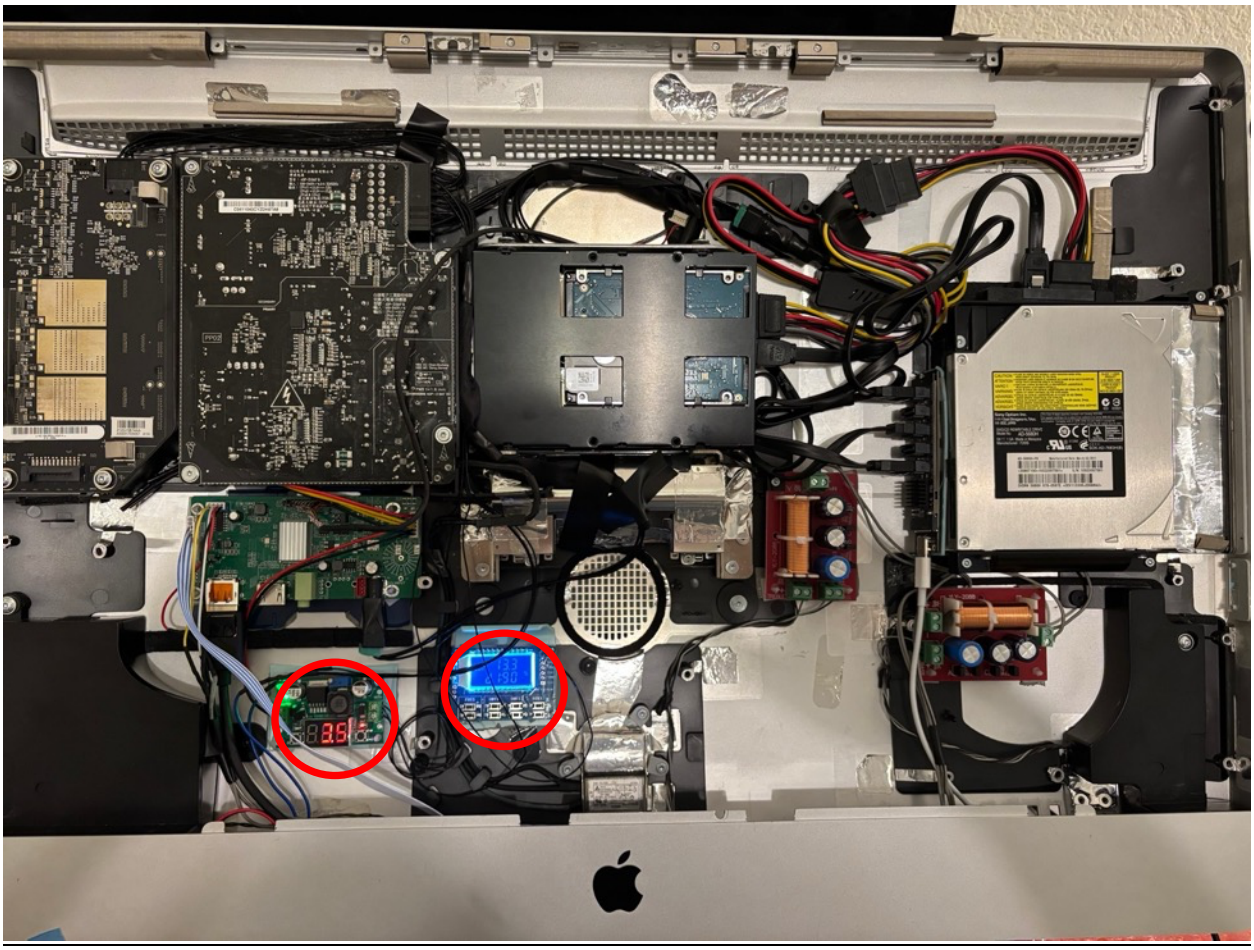
Test the display before moving on with any of the remaining internal components you desire to keep

Everything required to support display functionality is complete – best to test it out now before moving on with any other internal components
- Connect your desired video cable to the LCD driver board video input
- Connect the 16 pin MOLEX plug to the iMac power supply
- Ensure power is connected to the LCD driver board
- Connect the 6 pin MOLEX plug to the iMac inverter board
- Insert the display into the iMac case, ensuring that you don't pinch any wires in the process
- Connect the video cable from the LCD driver board to the two connections near the center-top of the backside of the display
- Connect the two inverter board connections (one at the bottom and one at the top) to the appropriate connectors on the back of the display
- Secure the display with at least one of its mounting screws to prevent it from accidentally falling out
- Finally, connect a video source power (e.g., MacBook Pro) to the LCD board and power up your display

If you are not planning on maintaining the functionality of any other internal components, this completes the conversion process and the display can be buttoned up.

Follow the steps below to maintain the ability to keep drives installed, use the speakers, and support cooling fans.

NOTE: I have yet to fully complete the items below for my conversion, but will be doing so soon. The details provided below are for informational purposes only at this time. The picture below is also not representative of the final configuration yet.



Power and data for the HDDs, and SuperDrive

1. I used the following 12Vdc to 5Vdc step down voltage converter to 15-pin power adapter to supply power to the drives – https://www.amazon.com/dp/B0CYBYTN6L?ref=ppx_yo2ov_dt_b_fed_asin_title

2. I used this SATA to USB 3.1 Gen 2 board to allow use of a single USB cable from my laptop to the access the drives (Note: The SuperDrive was not recognized by this adapter)

3. I am strongly considering changing this setup and using a multi-port USB Hub like this Anker Hub. This would allow for a single cable solution for both the video feed to the LCD driver board via HDMI and drive power supply and data access using USB to SATA converter cables. This should also support connection of the SuperDrive. *And it should also allow for a single cable connection solution to support functionality of the display and all my internal components* by using an HDMI cable to connect from the hub to the LCD driver board.

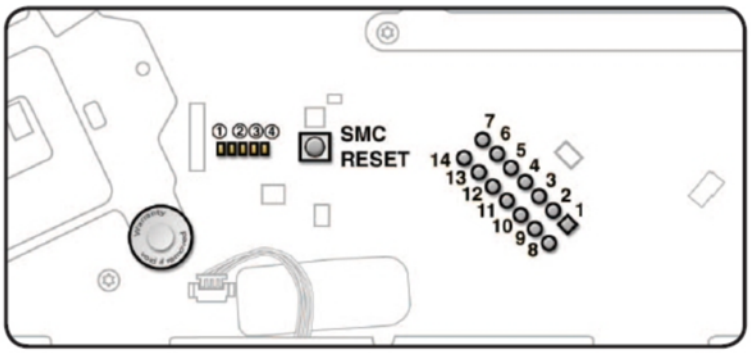
Audio Setup

1. The amplifier on my LCD board was too weak to drive the iMac speakers. I am purchasing a small amplifier board (approx. 3-5 watts) to install inside the display to fix this problem.
2. Crossovers are required to feed the proper frequencies to the iMac tweeter and woofer.
3. The iMac speakers wires as follows: Brown/Gray wire pair is Treble +/- and the Black/Gray wire pair is Bass +/-

Other Considerations

1. Cooling for the inverter and power supply – small blower fans
2. Cut away the air dam at the bottom of the inverter.
3. Brightness control pushbuttons.

iMac motherboard power supply connection – 14 pin MOLEX connector (providing for reference only)



Test Point	Function
Pin 1	Ground
Pin 3	5V power for Hard Drive(s). Note: If present, the 12V power will come directly from the Power Supply to the Hard Drive thru the power harness cable.
Pin 4	Standby 12V power (permanent power coming from power supply, present as long as AC cable is connected, even if computer is off); corresponds to LED #1
Pin 6	Backlight Control pulse width modulated signal (from logic board to LED backlight board, to adjust the backlight level setting according to user setup)
Pin 11	12V Run-Mode power to logic board (coming from power supply, present as long as system is on or asleep); corresponds to LED #2
Pin12	Power On Request signal (from logic board to power supply when power button is pressed)
Pin 13	Backlight Enable (signal from logic board to Backlight Controller board, to enable backlight

Note: The iMac main logic board schematics show Pin 12 is BL_EN and Pin 13 as PS_ON. This is the reverse of what is shown above from the service manual