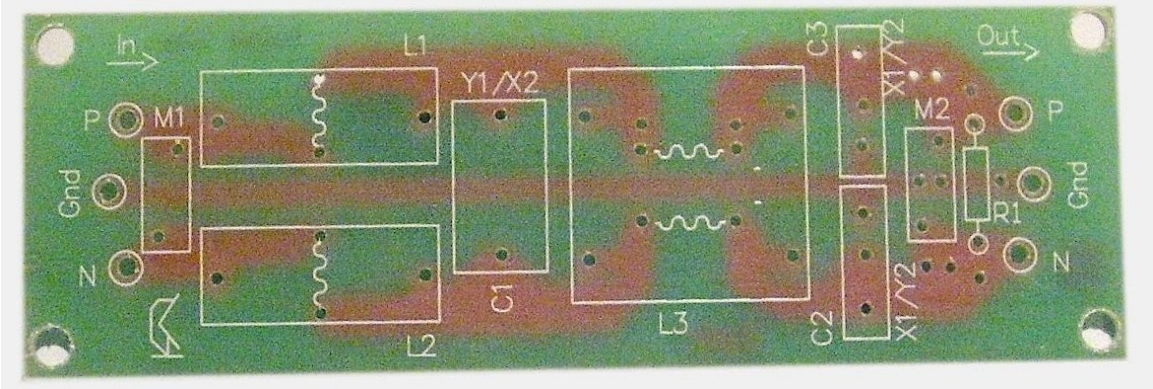
Common Mode and Differential Mode Surge Suppressor Power Line Filter PCB

From

Classic Valve Design



This product is designed for and use around **LETHAL VOLTAGES**. We assume the user has a reasonably competent grasp of line operated electronics at the time of sale.

Please assemble your units to conform with your local laws regarding power line-side equipment.

As today's products become increasingly complex and reliant on digital circuits, power line noise and surges have inevitably increased.

While the manufacturers of most products do a reasonable job to keep interference from their products to a minimum, the extra noise fed into the power line cannot be eliminated entirely.

Not only modern appliances, but natural sources too can generate surges and noise on the power line. Sources such as electrical storms, static buildup, tree contact, arcing connections are common causes of power line noise, especially in rural areas.

People with analog equipment, especially those with sensitive vacuum tube (valve) audio amplifiers, can be most susceptible to such noise riding in on the power lines to their homes and offices.

The CK-39 Power line Filter PCB is designed to help reduce, or eliminate, the most common types of power line noise found in homes.

Types of Noise

There are four types of noise found on power lines – **1)** common mode **2)** differential mode **3)** RFI, or Radio Frequency Interference is (thankfully) less common, as it's harder to eradicate and **4)** DC current on the power lines.

Common Mode noise is the type that is generated by most computer and television power supplies and digital appliances. The noise rides both wires (line and neutral) on a household system and are more or less in phase with each other.

Differential Mode noise is generated by motors, such as power tools, washer and dryer and other kitchen gadgets that plug in to the wall. Switching of heavy current also causes differential mode noise, such as an electric hot water heater turning on and off. This noise is out of phase on either side of the power line conductors.

Both Modes are generated by fluorescent lighting, especially compact fluorescents (the swirly bulbs).

Radio Frequency Interference is generated by compact fluorescents and computer power supplies, as well as 2-way communications equipment, like ham or CB radio.

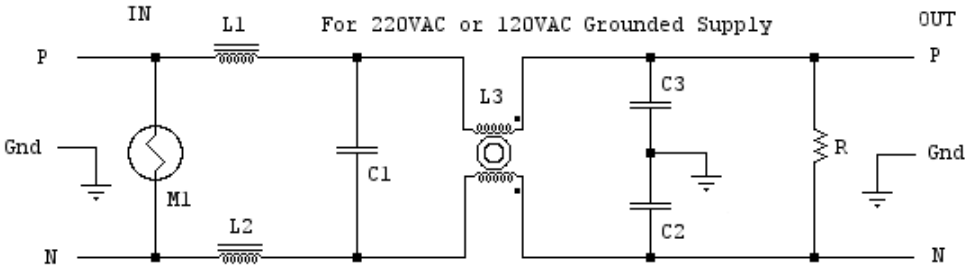
DC Current on the power lines is usually found only in industrial areas where asymmetrically conduction of HUGE equipment create a residual DC effect of the power line waveform.

This power line filter from ***Classic Valve Design*** is designed to take care of common and differential mode noise and surges with a grounded supply, can to some extent reduce RFI that is picked up by the power lines. It **CAN NOT** help with DC on the power lines. Extensive power line conditioning is required for that nasty mode of noise.

Circuit Configurations

Let's start looking at some things you can do with your power filter PCB. ***Figure 1*** is the recommended configuration for common and differential mode noise filtration and surge suppression.

Common+Differential Mode Line EMI/RFI FIlter



Sample Part Numbers
(as developed in our prototype)

L1, L2 = 100uH, 5A Toroid. Digikey PN 732-1425-ND.
L3 = 1mH, 6A Toroid. Digikey PN 732-1444-ND.
C1 = 0.47uF, 305VAC. Digikey PN 495-2322-ND.
C2, C3 = 0.0047uF Ceramic X1/Y2 Capacitor = Digikey P/N BC2359-ND
M1 = For 120VAC use: 130VAC Varistor. Digikey PN 495-1406-ND.
For 240VAC use: 250V Varistor. Digikey PN 495-3785-ND.

Resistor = 1 Meg, carbon composition. Digikey PN 0F105JE-ND.

Figure 1

L1, L2 and C1 provide differential mode filtration in this circuit. L3, C2 and C3 provide common mode filtration and RFI reduction. M1 is a transient surge suppressor that clamps any power line spikes before they can cause trouble. The resistor provides a DC path to discharge the capacitors, should any DC buildup appear on them (not to be confused with the DC current type noise).

If you wish to *protect the line* from a noisy source, a power tool or kitchen appliance is a good example, forgo M1 and use the M2 position (***Figure 4***).

It should be noted that while a ½ watt carbon composition is specified, a 1 or 2 watt Metal Oxide resistor is suitable. Carbon *film* or metal *film* should **NOT** be used here. That is because a carbon or metal oxide resistor can take microsecond surges of several tens of times their wattage ratings, as typically found on a power line. The film types (other than the special thick film industrial types) tend to just act like a "fuse" and open circuit.

If you just want a common mode power line filter, the CK-39 can be simplified as found in ***Figure 2***.

Common Mode Line EMI/RFI FIlter

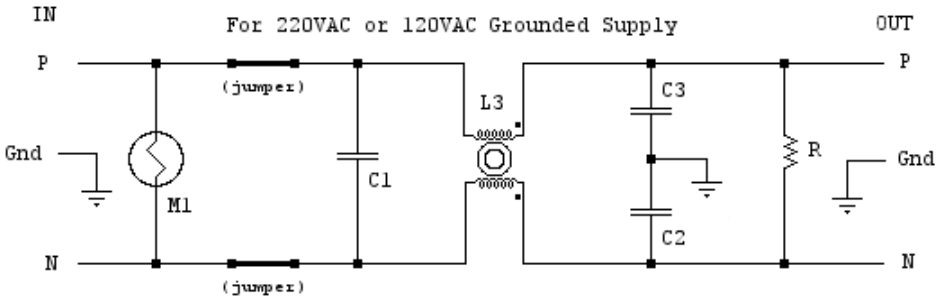


Figure 2

The CK-39 can be used with ungrounded supplies as well. But it should be noted that there will be no RFI reduction with an ungrounded supply. See ***Figure 3*** for the ungrounded version of ***Figure 2***.

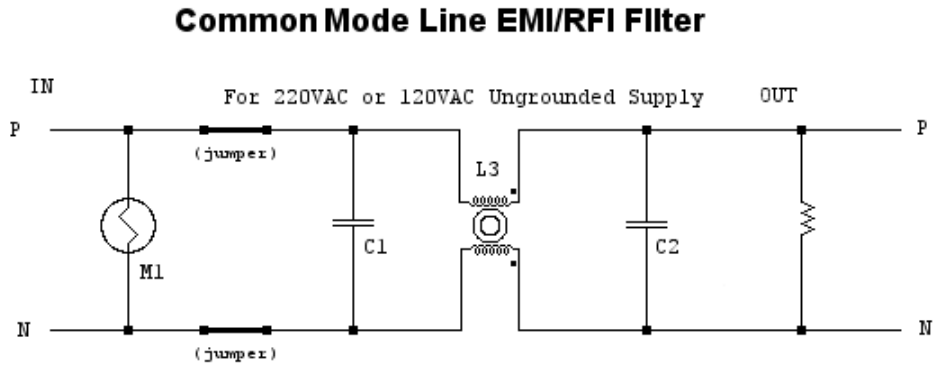


Figure 3

Figure 3a shows C2 position for the ungrounded version.

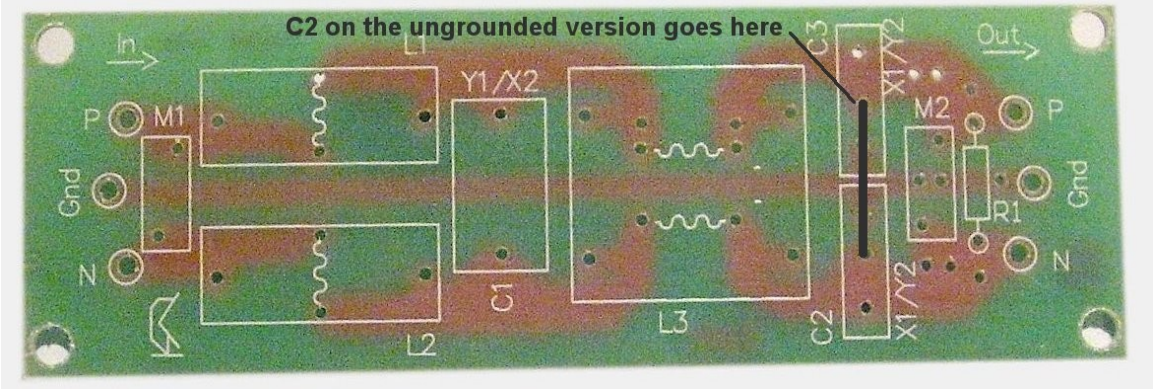


Figure 3a

The CK39 filter board is stackable. If you wish to use it in conjunction with another CK-39 or other power line filter, like a Sola or Corcom, ***Figure 4*** gives the configuration.

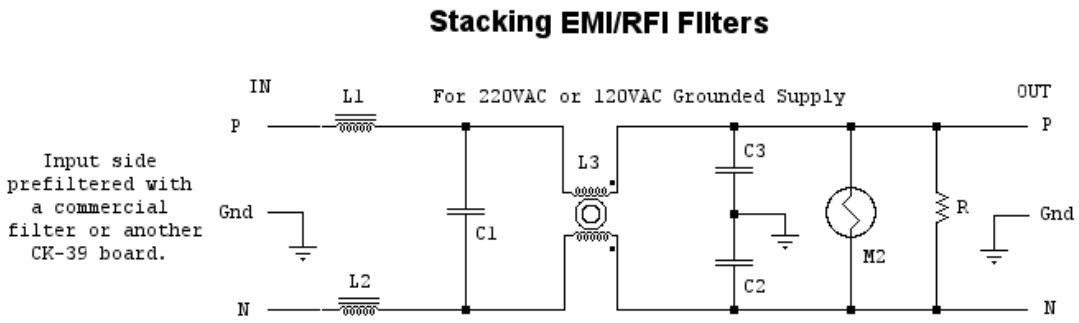


Figure 4

Figure 4a shows the prototype model of the CK-39 used by **Classic Valve Design**.

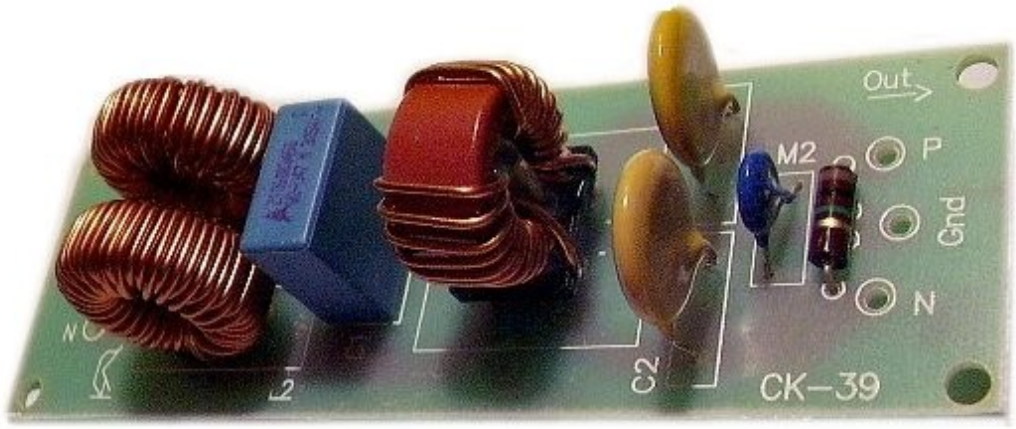
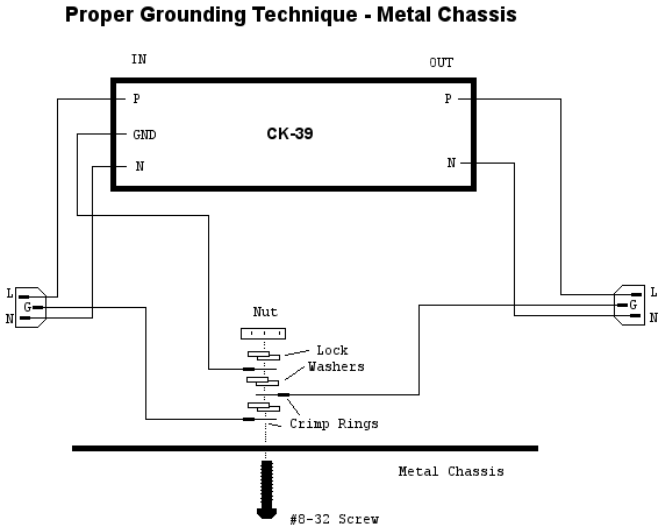


Figure 4a

Grounding and Safety

You may of course chose to place your CK-39 inside your power amplifier, preamp, or other audio equipment, but it's also advantageous to make an inline filter to use with a power bar for many pieces of audio equipment at once.

For safety sake, here are some examples of wiring your CK-39 in ***Figures 5, 6 and 7***.



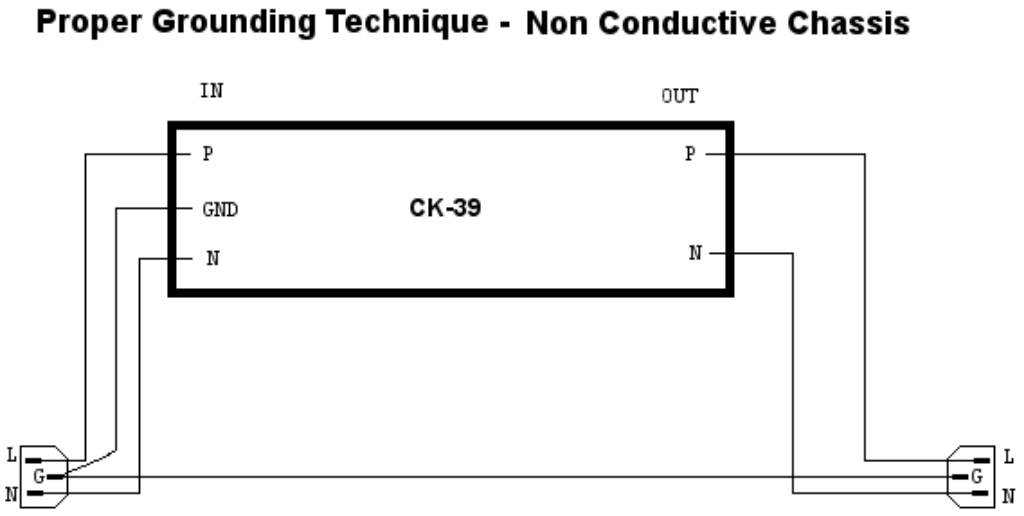


Figure 6

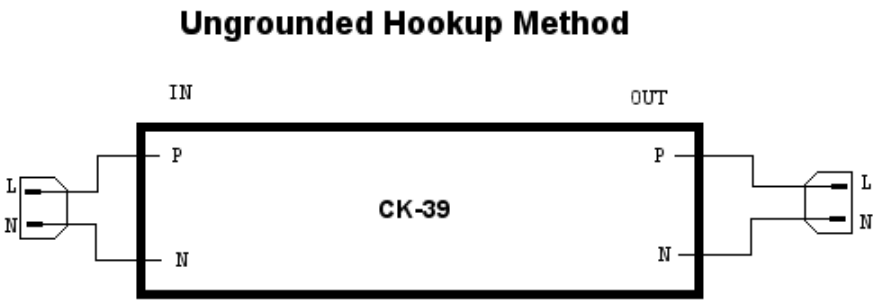


Figure 7