HARMONICS LIMITED
The GreenWay to Sustained Energy $avings
by Jefferson Electric

Basic Technical Operation and Construction of the Harmonic Suppression System (HSS®)

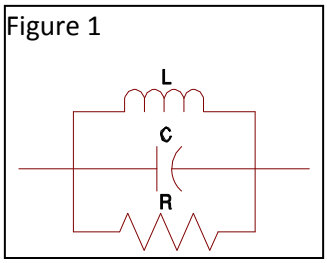
Informational Document from Harmonics Limited IDHL-3 "Basic HSS Construction"

HSS OPERATION

General. The HSS is an LCR circuit, tuned to have its maximum impedance at the 3rd harmonic (180Hz for 60Hz distribution systems.) The primary circuit consists of reactors and capacitors connected in a parallel-resonant tank. A Thevenin-equivalent circuit is shown as Figure 1.

The parallel-resonant tank circuit. The parallel-resonant tank circuit is characterized by a near-infinite impedance at the tuning frequency and a relatively low impedance at all other frequencies. It is often referred to as an "inverse notch" filter. Such filters are most often used in high-frequency equipment to prevent interference of damaging RF energy flow into sensitive circuits. In the harmonic suppression system the circuit is used to prevent the flow of 3rd-harmonic currents, thus keeping single-phase non-linear loads from drawing extra harmonic current throughout the electrical distribution system.

Figure 1



Tuning. The tuning frequency of a tank is determined by the equation $f = \frac{1}{2\pi\sqrt{LC}}$

where *f* is the tuning frequency in Hz, *L* is the inductance in Henrys and *C* is the capacitance in Farads. In designing the harmonic suppression system the value of *L* is selected to provide a low impedance at 60Hz (generally ≤ 0.05 Ω.) The value of *C* needed to tune the circuit to 180Hz is determined by the tuning equation. The higher the rating of the filter in amperes, the lower the fundamental impedance. This ensures that fundamental power losses through the filter will be low.

R. The value of R does not appear in the tuning equation. R is incorporated into the circuit for two reasons. The first is to reduce the filter Q, thereby decreasing the sharpness of the tuning frequency. This enables the use of components with standard L and C tolerances, rather than requiring that each component be "tweaked" to a very exact value. (This in turn results in a less expensive filter which is more cost-effective to the customer.)

The second reason for R in the circuit is that the National Electrical Code requires that all capacitors used in AC power circuits have a bleeder resistor to reduce the voltage on the capacitor to less than 50 volts within five minutes after disconnection.

Even though the voltage on the capacitors in the filter never exceeds 25 volts the presence of the resistor ensures that there will be no questioning the filter installation by local code inspectors.

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BASIC FILTER CONSTRUCTION

Reactors. Reactors are custom designed to provide suitable low impedance at the fundamental frequency. Reactors are insulated with 180 °C varnish systems, are sized for high harmonic loads, and are rated to carry the full-load current for each unit size. For instance, a 45 kVA reactor is rated to continuously carry 125 amps. Reactors are UL component certified.

Capacitors. Capacitors are metalized polypropylene film power capacitors. Although the actual voltage across the capacitors, when the filter is operating, is only about 20 volts AC, to ensure reliability the capacitors used are design rated for continuous operation at 240 volts AC. Capacitors are in parallel with the reactors and the tank circuit is connected in series with the neutral wire. There are no capacitors connected phase-to phase or phase to neutral in the assembly.

Resistors. Wire-wound are used. Resistors are rated for power dissipation at least 10 times the power level at which they operate. Resistors are UL rated or component recognized.

Hardware. All wires are neoprene insulated with a UL temperature rating of 105°C. Wires are terminated with bolted crimp-on terminals or screw pressure lugs. All lugs and terminal blocks are UL rated or component approved.

Enclosures. Enclosures are custom manufactured by Hoffman or equivalent manufacturers. Material is 11-14 Ga. steel depending on enclosure size. Finish is ANSI 61 gray polyester powder coating. Sub plates are 12 Ga. galvanized steel. Standard HSS enclosures are rated NEMA/UL type 1. For outdoor use, NEMA/UL type 3R enclosures are available.

RELIABILITY OF HARMONIC SUPPRESSION SYSTEMS

The HSS is a totally passive unit consisting of inductive and capacitive elements connected in a resonant tank circuit. There are no active elements. (Since there are no active elements, reliability is extremely high and periodic maintenance is not required.)

SUMMARY

The Harmonic Suppression System uses standard circuits to block 180Hz current flow. All components used in these units are selected and designed for reliability and long lifetime. There is nothing “magic” or “secretive” about how these devices are built or how they operate. You can choose to use them with full confidence that they will provide for you, as they have for others, the best, most cost effective, most reliable, and safest means to eliminate 3rd harmonic currents and the problems they cause from your electrical distribution system.

For further information contact:

- Harmonics Limited Customer Service at (800) 892-3755
  customerservice@harmonicslimited.com