

## Frequently Asked Questions

### Tune EMI Facility Filter

**What is the TUNE EMI Facility Filter?** The TUNE Filter is a passive inductive Filter that Filters 'leading power factor noise' out of the electric panels within buildings. 'Noise' is any frequency of current that is not the 60 Hz fundamental waveform.

**How much electricity does the TUNE Filter use?** None, because it is an inductor connected in parallel on the neutral bus bar.

**How long does the TUNE Filter last in a building?** Tune Filters have a 10+ year life expectancy with a full seven year warranty.

**How long has this technology been around?** Inductors have been applied in electrical distribution systems for over 100 years, but never applied in this manner. The TUNE Filter was designed in 2012. The USPTO issued the patent in August 2017.

**Is there a warranty on the TUNE Filter?** Yes, currently the device carries a 7-year warranty and a copy of the manufacturer's warranty is available on request.

**How many installations use this technology?** There are thousands of TUNE Filters installed in the USA. Multiple customer case studies and third-party engineering reports are available on request.

**Is it safe? Has there ever been a safety incident involving this product?** There has never been an incident reported regarding safety or issues caused by the TUNE Filter. UL certification was established in 2013 under file number E464646. UL has safety tested the product.

**How long does it take to install?** Depending on the neutral busbar arrangement, a typical installation takes 15 to 30 minutes by a licensed electrician. Complete installation instructions are provided with each TUNE Filter shipment. Technical assistance is available to support your successful installation, via video or phone support.

**Is there a patent?** Yes, patents are issued for the TUNE Filter and pending for additional, expanded research. The TUNE Filter was awarded a patent and registered with the US Patent and Trademark Office (USPTO) in 2017. Ongoing research requires additional patent filings since the body of knowledge continues to expand.

**What is 'noise' in an electrical system?** Electronic equipment, including HVAC controllers, variable speed drives, computers, audio/visual equipment, electronic lighting ballasts, LED drivers and CFLs (compact fluorescent lights) convert AC power to DC to power these electronic devices. As a result of that electrical change within these devices, the current sinewave of the 60Hz fundamental frequency is distorted, by the creation of additional frequencies from the power conversion within these electronics devices. This is commonly referred to as 'noise'. Electrically, 'noise' has been defined as the total harmonic distortion of the particular electric loads. The harmonic distortion is measured by a multiple, from 1 to 50, of the fundamental 60Hz frequency as a way to quantify it in power monitoring. The noise

in the circuit finds its way to the neutral busbar within every panelboard or load center. This has been part of every electrical distribution system since the 1960s and is an increasing problem globally.

**What background material supports the claims of ‘harmonic noise’ in a building?** Multiple articles are available that confirm that leading power factor loads, capacitive in nature, create sine wave frequencies outside the 50 and 60 Hz fundamental frequencies. These articles conclude that the installation of a passive, inductive Filter can reduce the ‘noise’ caused by these loads and as a result, reduce electric KWH consumption in a building.

**Are there any 3<sup>rd</sup> party engineering studies to support the claims about the TUNE Filter?** Yes, multiple different third-party, independent energy engineering firms have provided reports on multiple installations about the positive impact of the TUNE Filter. These reports are prepared to ASHRAE and IPMVP standards, using regression analytics and paired-T analysis. The reports ‘confidence factors’ are over .98 ‘confidence rating’ in each of their statistical reports (where 1.0 is perfect and .80 and higher are considered statistically relevant).

**Is the TUNE Filter a ‘power factor correction’ Filter or device?** In electrical engineering, the ‘power factor’ of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number in the closed interval of 0 to 1 for lagging power factor and 0 to -1 for leading power factor loads. A power factor of less than one means that the voltage and current waveforms are not in phase, reducing the instantaneous product of the two waveforms ( $V \times I$ ). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. A positive power factor is indicated in power monitoring devices, when the measuring device is seeing a lagging power factor load, which has an inductive profile. A negative power factor is indicated in power monitoring devices when the measuring device is recording a leading power factor load, identified as a capacitive profile. The TUNE Filter is applicable to these types of capacitive loads in correcting the power factor by reducing harmonic current content associated with the capacitive profile. Typically, these harmonics are found from the 11<sup>th</sup> to the 65<sup>th</sup> on the neutral bus bar.

**It sounds like a gimmick?** As far as a gimmick, people do not understand that the TUNE Filter filters the ‘noise’ of leading power factor loads, like switching power supplies found in LED fixtures, desktop and laptop computers, and VFDs. The TUNE Filter adds inductance to the neutral and reduces the resistive component of the neutral as seen by these leading power factor currents. The result is a mathematical offset of the capacitive nature of the above loads.

**How many TUNE Filters does a building need?** To gain the most effective benefit in any electrical distribution system, the TUNE Filter is installed as close to the electrical load as possible. The most convenient point is the neutral bus bar in each panelboard (sub-panel) in a building. The TUNE Filter is not installed at the building’s service entrance (main distribution panel(s)), but closest to the loads that use the AC power and create the ‘noise’.

**Does the TUNE FILTER affect the meter from the power company?** The TUNE Filter mathematically offsets the capacitive harmonic component of the current waveform of each circuit that is connected to the neutral bus bar. The reduction in the current on the neutral does reduce the amount of KWH as is calculated by the utility meter according to the formula,  $P=I^2R$ .

**How do I know the TUNE FILTER is working?** During installation the unit is checked to verify that current is flowing through the Tune Filter. They measure the current, using a clamp-on meter or a toroid type CT that has a Rogowski coil, on the TUNE Filter leads is a confirmation that harmonic current is flowing through the TUNE Filter. During the annual panel inspections Tune suggests taking the measurement again to verify current is still flowing through the unit. If the unit fails, you will see an increase in KWh usage which could indicate the device is not functioning correctly and inspections may be warranted. In the history of Tune only one device has failed in the first 7 years.

**What happens to my building if the TUNE Filter quits working?** Nothing! The TUNE Filter is installed in parallel on the neutral bus bar. An Open circuit inductor poses no safety issue within the panelboard. If there is 0 value current reading on the TUNE's leads, then the inductor is either not working or there are not any capacitive type loads that are currently in the ON position. Everything should operate even if the TUNE Filter quits working.

#### **Is there a test for THD in a building?**

Examples of non-linear loads on a power system are rectifiers (such as used in a power supply), and arc discharge devices such as fluorescent lamps, electric welding machines, or arc furnaces. There are power meters available from different manufacturers in the marketplace today that can accurately record THD. The less expensive meters do not have the capabilities to detect current harmonic waveforms to the 50<sup>th</sup> harmonic frequency.

#### **What does the Power Company Measure through the Meter**

The utility company charges you for the power you use based on the monthly readings of an electric meter that measures the **current** passing through the service entrance into your electrical service panel. The meter can either be a mechanical analog meter that is read monthly by a utility service person who visits your home, or a newer digital/SMART meter that may send information via internet or radio signals.

#### **Electrical Usage is Measured in Kilowatt Hours**

Whatever form of meter you have, it measures the amount of electricity you use in watts, or more specifically, *kilowatt hours*. A watt is the product of the voltage and current adjusted by power factor in an electrical circuit:  $1 \text{ volt} \times 1 \text{ amp} \times 1.0 \text{ PF} = 1 \text{ watt}$ . But this formula represents merely the measure or snapshot of electrical energy. To measure actual energy *usage*, you have to add an element of time. Therefore, electrical usage is a measurement of watts used over a period of time. Your electric meter records electricity usage in kilowatt-hours. In simple terms, 1 kilowatt hour = 1,000 watt-hours. For example, if you turn on a 100-watt light bulb for 10 hours, the energy usage is calculated as  $100 \text{ watts} \times 10 = 1,000 \text{ watts}$  (or 1 kilowatt hour).

Since 'noise' is defined as 'any current used at a frequency other than 60Hz wave form,' it is an addition to the 60Hz loads. The electric meter measures both the noise and the 60Hz loads. By using the TUNE Filter, and filtering current that is not of the 60Hz waveform, you reduce what the meter measures, thereby reducing your power bill.

#### **The Math**

In electricity, Voltage (V) equals Current (I) times Resistance (R), and the formula is  $V=I \times R$ . Watts (W) equals Current (I) times Voltage (V) with a formula  $W=I \times V$ . Kilowatts is 1,000 watts or KW. Kilowatts consumed in an Hour is displayed as KWH. By filtering the Current (I) and taking 'noise' out of the circuit, we reduce the Current being measured. Thus, the power, as measured by  $P=I \times V$  is reduced.

**How does the Filter work? How does it attract harmonic frequencies 3, 5, 7, 9, 11?**

Most of the frequencies' that it attracts are higher than these because its design is mainly for devices that require a neutral. The 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup>, and 9<sup>th</sup> harmonics are usually found in 3 phase, 3 wire loads like charging circuits for UPS systems and some variable frequency drives. Today's computer power supplies and LED power supplies operate differently from those charger circuits. The Filter has lower resistance than the neutral bus bar, that it is in parallel with, and by trimming the leads as short as possible, we further reduce that resistance and attract current above the fundamental frequency of 50/60Hz.  $V=I \cdot R$ , no, it is the power formula, which is a measurement of watts, i.e.,  $P=I^2 R$ . When these currents encounter the junction of the inductor and the higher resistive nature of the neutral bar, the inductor is the electric path of choice of any current that is leading in nature, which is cap active. The electromagnetic field of the inductor offsets the capacitive nature of this current waveform in its electromagnetic field. Yes, a certain amount of energy is dissipated heat, but those elements of heat are usually the 3<sup>rd</sup>, 5<sup>th</sup>, and 7<sup>th</sup> harmonic components.

**Tune Filter reduces energy consumption in a building, but in what ways specifically does the Filter improve the power quality?**

In simple terms, by removing the harmonics with our filter, we are improving the power quality. The power quality for these neutral loads is improved by the elimination of the higher harmonic values found in the current waveform creating cleaner electric that makes every electronic device run more efficiently.

**Why is the Filter recommended for subpanels with power output of 480 volts or less AC power?**

The parallel Filter was created as a low-cost alternative to other series rated devices designed for 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup>, and 9<sup>th</sup> harmonics. A series-rated Harmonic Mitigating Transformer may cost between \$5,000 and \$10,000, take hours of down time to install, require annual inspections and adjustments, and consume 1-2% additional power. An active cancelling frequency tuned harmonic mitigation system can cost tens of thousands of dollars. Our TUNE Filter is specifically designed for 480, 480/277, 240, 208, and 208/120 load panels with neutral loads. Higher voltage panels require different product solutions for their issues.

**If the load panel has more than 480V, how do you propose to help a customer?**

The TUNE Filter is not applicable in these situations.

**What is the best environment for the Filter to provide highest capacity performance? Is there specific power output the subpanels need or should be exhibiting? What buildings benefit most from the Filters?**

There are multiple conditions we have encountered where the performance exceeds our expectations. The characteristics of the buildings and use of the buildings vary widely. Residential installations exhibit the broadest range of savings and can be associated with both the impact of the Filter and the panel 'clean-up' that an electrician does when the Filter is installed. The typical performance range in homes and offices is 10 to 15% savings. We have seen higher savings when the loads are heavily electronic. We have seen lower savings when the loads are a heavy mixture of 3 phase 3 wire subpanels servicing inductive pumps and motors. **All in all, the panelboard requires a neutral bar for the application to be successful.**