Frequently Asked Questions

Rev B

For Series:	EMS12

1. **What is this oscillator series?**

This series of devices are oscillators where the output frequency is primarily controlled by an internal micro-electro-mechanical system (MEMS) resonator and an integrated complementary metal-oxide semiconductor (CMOS) circuit. Utilizing a proprietary MEMS resonator design and exclusive processing methods, this oscillator series is calibrated to a specified frequency prior to shipment to the customer. Spread spectrum oscillators have the output frequency intentionally modulated in order to reduce the electromagnetic interference (EMI) on the output signal.

2. **What are the typical customer circuit applications for this oscillator series?**

This oscillator series can be used in any of the following applications:

- Synthesizer or System Reference
- Clock Distribution

3. **What are the typical end item products for this series?**

Here is a list of the common applications and products:

- Scanners, Printers, and Modems
- LCD Displays
- Portable Media Players
- Digital Cameras and Gaming Products
- Notebook Computers
- Video Cameras and Recorders
- Graphic Cards and Interface Controllers
- CPU and Memory Buses

4. **What technical benefits does this product series offer?**

This oscillator series offers:

- Improved frequency stability through the use of a MEMS resonator
- 30,000G shock resistance
- Tri-state (High Impedance) or Power Down (Logic Low) and Spread Disable options
- Linear, 32 kHz modulation profile for reduced output EMI
- Wide range of center and down spread percentage options
- High speed CMOS output with controlled rise and fall times
- Superior cycle to cycle period jitter performance
- Four pad moisture sensitivity level 1 (MSL1) rated QFN-type plastic SMD package
- RoHS Compliant (Pb-free) with high temperature 260°C reflow capability

5. **What are the construction characteristics of this product series?**
This product series consists of a single LVCMOS application specific integrated circuit (ASIC) and a MEMS resonator die stacked inside an industry standard QFN-type plastic injection molded package. This assembly configuration results in superior thermal performance, high reliability, and low lead inductance. The termination I/O pads consist of Ni/Pd/Au metallization.

6. **What is the input supply voltage for this product series?**
The nominal supply voltage and tolerance is listed on the datasheet.

7. **What are the input current specifications for this product series?**
The input current specification is listed in milliamps as a maximum value and is listed on the datasheet.

8. **What are the frequency stability and operating temperature range options for this product series?**
The available operating temperature range and frequency stability options are listed on the datasheet.

9. **Does this series offer tri-state or power down output options?**
This product series offers a tri-state or power down output control option for power management. If the power down function is selected, then all active circuitry within the oscillator is shut down when the voltage at the control pad (pad one) is set to a logic low state. In this condition, the output signal is forced to a logic low with a weak pull down (100k ohm typical) resistor and the input current on the power supply line is negligible. The stand-by current specification is listed on the datasheet.

If the tri-state option is selected, the output is three-stated (tri-state) when the voltage at the control pad (pad one) is set to a logic low state. In this condition, the internal oscillator circuit continues to operate. However, the output signal is now high impedance and the input current on the power supply line is only slightly decreased from normal operating current. The disable current specification is listed on the datasheet.

Note: The oscillator has an internal pull up resistor on the control pad (pad one). The series datasheet provides the V_{IH} and V_{IL} thresholds for control of the tri-state and power down functions.

10. **Can I obtain a non-tri-state or a non-power down function for this product series?**
This product series only offers the tri-state or power down control options on pad one of the oscillator. The customer can use this oscillator series as a non-tri-state or non-power down oscillator by setting the voltage on tri-state control (pad one) to either no connect or logic high. The oscillator has an internal pull up resistor on tri-state control (pad one). The datasheet provides the V_{IH} and V_{IL} thresholds for control of the tri-state and power down functions.

11. Does this series offer a spread disable output option?

This product series offers a spread disable output control option for signal management. The spread disable function is only available with the down spread option. If the spread disable option is selected, then the spread spectrum output modulation is disabled when the voltage at the control pad (pad one) is set to a logic low state. In this condition, the output signal is clocking, but the output clock is not modulated.

Note: The oscillator has an internal pull up resistor on the control pad. The series datasheet provides the V_{IH} and V_{IL} thresholds for control of the spread disable function.

12. How do I specify the overall frequency stability for this product series?

Ecliptek defines the frequency stability performance of the device inclusive of specific oscillator operating conditions. This is often called the "Inclusive Method". Ecliptek specifies the following parameters for this series of product:

- Calibration Frequency Tolerance at 25°C
- Frequency Stability over Operating Temperature Range
- Supply Voltage
- Output Load
- First Year Aging at 25°C
- 260°C Reflow
- Shock and Vibration

13. What is oscillator aging and what are the aging specifications for this product series?

Aging is the systematic change in frequency with time due to internal changes in the MEMS and/or oscillator. Aging is often expressed as a maximum value in parts per million per year [ppm/year]. The following factors effect oscillator aging: adsorption and desorption of contamination on the surfaces of the MEMS resonator, stress relief of the mounting and bonding structures, material outgassing, and seal integrity. The oscillator aging specification is listed on the datasheet.

14. What is the cycle to cycle period jitter performance for this product series?

Period jitter is the measure in the time domain and is specified in picoseconds (pS). Peak to Peak and rms period jitter are commonly specified for non-modulated clock oscillators and are defined over a number of cycles. Due to the output frequency modulation, only cycle to cycle period jitter is specified on spread spectrum clock oscillators. Cycle to Cycle period jitter is measured in the time domain and is defined as the worst case clock period deviation of adjacent cycles.

Because the modulation frequency is substantially slower than the output frequency, the spread spectrum modulation has very little impact upon the cycle to cycle or short term jitter. Ecliptek uses a proprietary design, exclusive processing methods, and a unique ASIC output driver circuit enabling this product series to have exceptionally low cycle to cycle period jitter. The cycle to cycle period jitter parameter is listed on the datasheet.

15. What is duty cycle and what is the duty cycle specification for this product series?

Duty cycle is the measure of output waveform uniformity. This term, also referred to as symmetry, is a measurement of the time that the output waveform is in a logic high state, expressed as a percentage (%) of the clock period. This parameter is measured at a specified voltage threshold or at a percentage of the output waveform amplitude. Measurement thresholds, load conditions, and duty cycle limits are listed on the series datasheet.

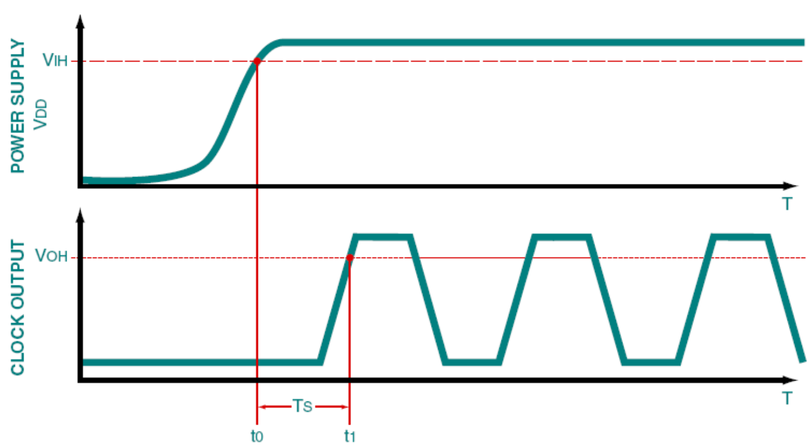
16. What are the output and output load characteristics for this product series?

Ecliptek offers this product series with a low voltage high speed CMOS driver that enables the output signal to swing from ground to V_{DD}. The oscillator output topology is designed so as to optimize circuit load matching and signal performance. Signal integrity is optimized when the low impedance output of the oscillator is driving a high impedance-low capacitance input. The output load specification is listed on the datasheet.

17. Is start-up time specified for this product series?

As shown in the figure below, start-up time is defined as the time (t_0) from when the power supply reaches its specified V_{IH} value to the time (t_1) the oscillator output signal amplitude reaches its steady state V_{OH} output logic high level and the output is within the specified frequency tolerance.

Figure: Oscillator Start-up Timing Diagram



In order to ensure proper start-up, the power supply start-up should have an exponential curve typical of a capacitive charge of a linear voltage ramp. The start-up time specification is listed on the datasheet.

18. Can I use this product series to drive my downstream phase lock loop (PLL)?

Most PLL's are designed to work properly when driven by both modulated and un-modulated clocks. However, one should take extra precautions in circuit design and implementation when using a spread spectrum clock due to PLL tracking rates, loop bandwidths, response times, and jitter performance.

19. What is EMI and why is it important?

EMI is defined as a naturally occurring phenomenon when the electro-magnetic field of one device disrupts, impedes, or degrades the electro-magnetic field of another device via radiated and/or conductive paths. EMI can cause two or more electronic devices to interfere with each other and affect their performance and operation.

20. Do MEMS oscillators emit EMI?

High speed frequency sources such as clock oscillators, phase lock loop (PLL) synthesizers, and other types of clock signal generation devices are a major source of EMI in electronic circuits. Therefore, EMI reduction is a major concern for designers utilizing these clock generation devices.

21. How do I reduce EMI without using a spread spectrum clock oscillator?

Conventional PCB design and fabrication methods of EMI reduction include multiple ground and power planes, discrete component filtering (suppression), and enclosure shielding (containment). Although these EMI reduction methods are effective, they can have a substantial impact to the overall product cost. An alternative to some of these EMI reduction techniques and the use of a traditional non-modulated oscillator is the inclusion of a spread spectrum clock oscillator in the clock distribution system. The use of such an oscillator can significantly improve EMI and reduce overall system cost.

22. How is EMI emitted in a standard non-spread spectrum clock oscillator?

A traditional non-modulated oscillator generates an output signal at the intended output frequency. In addition to the energy emitted at the fundamental frequency, there are large amounts of radiated electromagnetic emissions at its harmonic frequencies. These types of oscillators also generate electric signals at frequencies slightly lower and higher than the intended output and radiate electromagnetic waves over a frequency spectrum. The range of the frequency spectrum is dependent upon the mechanical and electrical design of the oscillator, power supply regulation, output termination, and printed circuit board layout.

23. What is the measurement parameter for EMI?

EMI is a measurement of radiated energy from a frequency source and is typically measured in dBmV/m (decibel-volts per meter) at a given frequency. This parameter is larger for higher amounts of radiated energy. Thus, the more energy emitted from a frequency source, the larger the resulting electric field and EMI.

24. When discussing EMI, what are peak emissions and average emissions?

As mentioned above, a non-spread spectrum oscillator has radiated emissions over a given frequency spectrum. When defining the frequency spectrum for the EMI measurement, one wants to distinguish between the peak electro-magnetic emissions and the average electro-magnetic emissions. The average emission is defined as the average dBmV/m level over a given frequency spectrum. Peak emission is defined as the maximum dBmV/m level at any frequency over a given frequency spectrum.

25. Is EMI regulated by the FCC?

EMI is subject to strict regulations by the US Federal Communications Commission (FCC) and other international regulatory bodies whose goals are to limit the amount of EMI electronic devices emit and to prevent damage to the human body and interference between electronic devices.

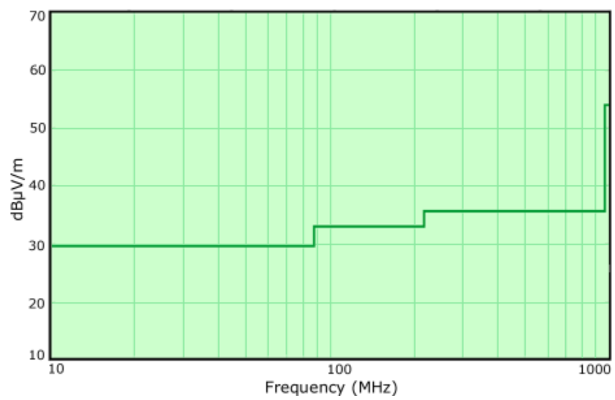
26. What are the different FCC class regulations?

The FCC's Class A regulations apply to industrial applications and the Class B regulations apply to residential or consumer applications.

27. What are the FCC emission standards for EMI regulation?

Today, FCC regulations are primarily concerned with peak emissions at any given frequency, not the average emissions over a given frequency spectrum. Thus, a circuit designer should focus their EMI design efforts on reducing the peak emissions at any given frequency within the frequency spectrum, not the overall average emissions within the spectrum. The figure below shows a FCC Class B plot of power (dBμV/m) versus frequency (MHz) for the peak emission requirements (at ten meters).

Figure: FCC Class B Peak Emissions



28. What is a spread spectrum MEMS oscillator and when is it best to use it?

A spread spectrum MEMS clock oscillator has the output frequency intentionally modulated in order to reduce the EMI of the output signal. Spread spectrum MEMS clock oscillators are best used in applications that require a reduction of EMI emissions in order to pass FCC EMI regulations. Spread spectrum oscillators reduce the EMI at the clock source, rather than down-stream in the clock distribution network. By reducing the EMI at the clock source, supplemental shielding enclosures and/or filtering components are not required, reducing assembly costs and improving system EMI performance.

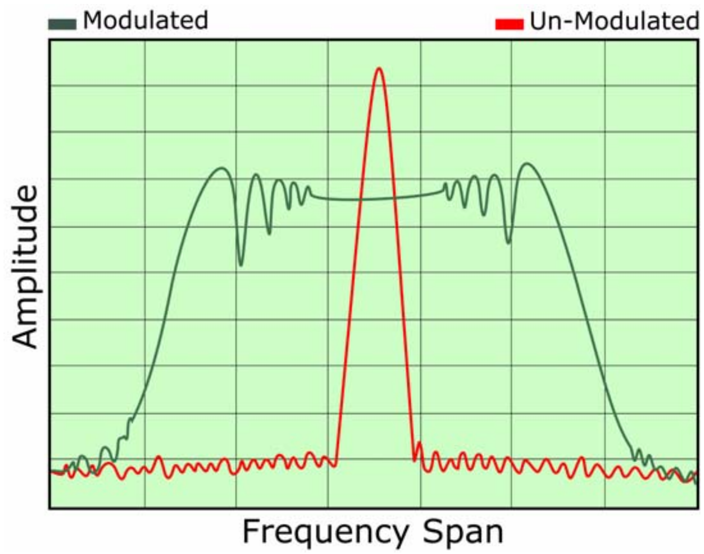
29. What is the purpose of modulating the output signal of a spread spectrum MEMS clock oscillator?

By modulating the output signal, the EMI on the output signal is spread over a larger frequency spectrum. The total amount of energy is still present, but the spreading of the output power over the frequency band results in a reduction of EMI at any one frequency. Regulatory bodies like the FCC have maximum limits for peak EMI emissions (i.e. emissions at any one frequency within the spectrum). Thus, a clock oscillator can be used to pass FCC regulatory EMI test requirements by reducing EMI peak emissions.

30. How does the spread spectrum MEMS clock oscillator modulation scheme work to reduce EMI?

The figure below shows a plot of output amplitude versus frequency for a modulated and un-modulated center-spread spectrum clock oscillator. As you can see from the figure, there is a large difference between the frequency span and the amplitude for a given modulated and un-modulated spread spectrum clock oscillator. By modulating the output frequency over a frequency spectrum, a reduction in output amplitude can be achieved. This reduction in output amplitude correlates with a reduction in radiated energy (EMI).

Figure: EMI Reduction Plot

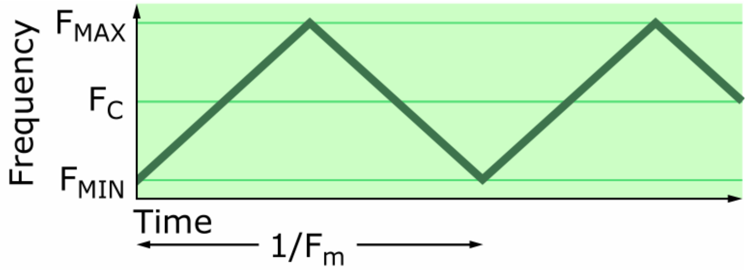


31. What is output frequency modulation width (or spread percentage)?

The primary factor that affects the amount of peak EMI reduction for a spread spectrum clock oscillator is the output frequency modulation width. The figure below shows a plot of output frequency versus time for an output of a non-linear modulated spread spectrum clock oscillator. The output frequency has a minimum (F_{MIN}), center (F_C), and maximum (F_{MAX}) frequency. The output frequency is swept linearly though a range of frequencies rather than being held at one constant frequency. This range parameter is often called output modulation width, output frequency spectrum, or frequency spread percentage.

The minimum (F_{MIN}) and maximum (F_{MAX}) output frequencies are often stated as a percentage (%) with respect to the center frequency. Ecliptek clock oscillators offer many output modulation width options. The wider the modulation frequency spread percentage, the larger the bandwidth of frequencies over which the energy is distributed, and therefore the more EMI peak reduction. The available output frequency modulation widths for this product series are listed on the datasheet.

Figure: Output Frequency Modulation Width



32. What is the frequency modulation profile used by this product series?

This product series uses the linear modulation profile that reduces edge peaking.

33. Why is the frequency modulation profile important?

Since the frequency modulation width is fixed and independent of the frequency modulation profile, the total radiated EMI is spread over the frequency modulation width. The goal of a spread spectrum oscillator is to spread the EMI energy evenly over the frequency modulation width, so as to eliminate any peaks or troughs.

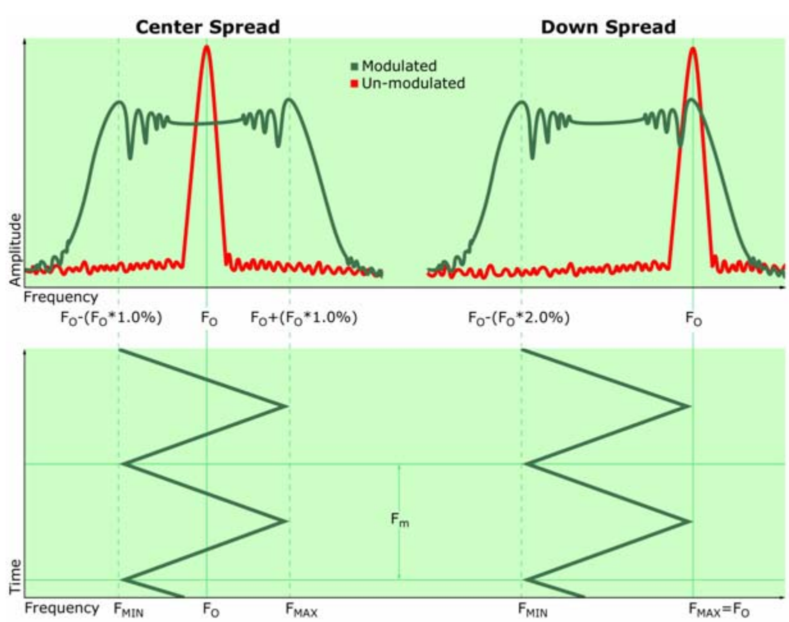
34. What is the output modulation frequency for this oscillator series?

The output modulation frequency (Fm), often called sweep rate, is defined as the inverse of the modulation period. The output modulation frequency can be found on the series datasheet.

35. What are the different output frequency modulation options?

Ecliptek offers two output frequency modulation options: Center Spread and Down Spread. The figure below shows an example of these two options.

Figure: Center and Down Spread Options



36. What is center spread modulation?

The instantaneous output center frequency (F_C) is the approximate midpoint of the minimum frequency (F_{MIN}) and the maximum frequency (F_{MAX}). The instantaneous output frequency will therefore always vary between F_{MIN} and F_{MAX}. The instantaneous minimum (F_{MIN}) and maximum (F_{MAX}) output frequencies are stated as a percentage (%) with respect to the center frequency (F_C). In the figure above, the center spread diagram provides an example of a 100MHz (F_O) device with a +/-1.0% center spread percentage. In this example, typical frequencies for F_{MIN}, F_C and F_{MAX} would be 99MHz, 100MHz, and 101MHz, respectively.

37. What is down spread modulation and when is it used?

When a system cannot tolerate an operating frequency higher than the nominal frequency, then a down spread option should be considered. In the figure above, the down spread diagram provides an example of a device with a -2.0% down spread percentage. For this example, if a customer was concerned about over-clocking and had a maximum operating frequency requirement of 100MHz (F_O), typical frequencies for F_{MIN} and F_{MAX} would be 98MHz and 100MHz, respectively.

38. Are there any disadvantages of using down spread modulation with an over-clocking application?

The disadvantage of down spread modulation is that the average output frequency will be lower than the nominal output frequency creating a trade-off between average output frequency, maximum over-clocking, and maximum frequency modulation amplitude.

39. Does Ecliptek offer an asymmetric (or down center) spread?

An asymmetric spread is defined as setting the output frequency at the half way point between the maximum down spread frequency and the center spread frequency. Asymmetric spreading is often used when over-clocking is a concern. This product series does not offer an asymmetric spread option. However, carefully selecting the proper center frequency and spread percentage can often accomplish the same design goals.

40. How much EMI reduction can be achieved using an Ecliptek spread spectrum MEMS clock oscillator?

Utilizing a proprietary design and an exclusive programming methodology, this oscillator series can achieve significant reductions in EMI emissions. The oscillator output frequency and frequency spread percentage are factors that determine the amount of system EMI reduction. An estimate of the EMI reduction can be made with the below formula.

$$\text{EMI Reduction (db)} = 10 \log [S * F_o / RBW]$$

where: S = Peak to Peak Spread Percentage
F_O = Nominal Output Frequency (in MHz)
RBW = Measurement Resolution Bandwidth (in MHz)

41. Can EMI reduction also be achieved at harmonic frequencies?

Spread spectrum oscillators have reduced EMI emissions at the main harmonic and even larger reductions at all other higher harmonics.

42. What are the instruments and test conditions used to measure the percent spread spectrum spread and EMI reduction?

Ecliptek utilizes a modulation domain analyzer to measure the center and down spread spectrum frequency percentage and a spectrum analyzer for measuring the reduction in output power.

43. How do I electrically test this product series at my facility?

The recommended electrical test fixture is listed on the datasheet.

44. Is this product series compatible with my existing assembly process equipment?

If the part number is specified with the TR packaging option, oscillator products are delivered to the customer in EIA481 compliant tape and reel packaging. Without the TR option, products are delivered to the customer in bulk packaging as specified on the datasheet.

45. Is this product series compatible with my existing reflow processes?

This product series is capable of withstanding industry standard high temperature (260°C, 10 seconds) convection reflow processes and is rated MSL1 per J-STD-020. The suggested solder reflow diagram is listed on the datasheet.

46. Is this product series RoHS compliant and Pb-free?

This product is RoHS compliant and Pb-free as defined in the Ecliptek RoHS Compliant (Pb-free) Roadmap.

47. How can I obtain a RoHS compliant (Pb-free) certification for this product series?

A RoHS and Pb-free product certification letter can be obtained directly from our website by using the Ecliptek RoHS/Pb-Free Certification Letter Generator.

48. Is an IPC-1752 material declaration available for customer review?

Ecliptek can provide a Material Declaration in compliance with IPC-1752 to assist customers with their material compliance requirements.

49. How do I layout my printed circuit board for this product series?

A suggested solder pad layout is listed on the datasheet. The customer should layout their PCB to include proper connections for the tri-state or power down input control function.

50. Who do I contact if I have additional technical questions about the use of this product series?

The Global Customer Support Team at Ecliptek can provide applications engineering support or answer customer technical questions.

51. How do I order an oscillator that has custom requirements not specified on the standard oscillator series specification sheet?

Please contact the Ecliptek Global Customer Support Team for additional support or questions regarding your oscillator requirements.

52. What are the environmental and mechanical specifications for this product series?

The environmental and mechanical specifications for this product series are listed on the datasheet.

53. What reliability information is available for this product series?

Failure in Time (FIT) and Mean Time to Failure (MTTF) reliability data is available for this product series within the product series qualification and reliability report found on the series home page.

54. Is thermal resistance information available for this product series?

θ_{JA} and θ_{JC} values are available for this product series and can be found on the Environmental / Mechanical section of the series homepage.

55. Are IBIS models available for this product series?

Input/Output Buffer Information Specification (IBIS) modeling information can be found on the series home page.

56. What is the marking scheme for this product series?

As shown on the datasheet, this series of product has marking content on the top of the part. This marking consists of a pad one locator dot and one additional line of alpha numeric marking. The marking represents an Ecliptek manufacturing identifier. This identifier is used internally at Ecliptek for manufacturing lot traceability. This manufacturing identifier provides no indication of part number or date code or output frequency. The datasheet provides the marking content.

57. Can I identify the Ecliptek part number or specification based upon the markings on top of the part?

In order to protect our customer’s intellectual property, the Ecliptek part marking does not identify the Ecliptek part number or specifications.

58. Where can I get the information regarding discontinued or End of Life (EOL) products?

Any Ecliptek part number currently under an End of Life statement will be identified as EOL on an Ecliptek quotation, along with a link to the EOL statement. This information can also be found on the End of Life Statements for Discontinued and Obsolete Products section of our website.

59. Is Ecliptek ISO 9000 Certified?

Yes, Ecliptek is certified to ISO 9001.

60. How can I obtain a REACH compliance statement for this product series?

A Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) compliance statement can be obtained directly from our website by using the Ecliptek REACH Compliance Resources page of our website.