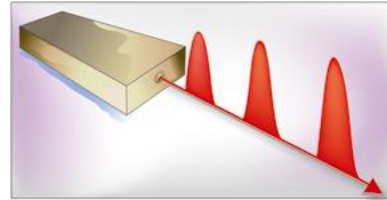


## *LightTime MPU-Series LightClock™*

### *High-Speed Optical Clocks for Next Generation MPU's*

LightTime introduces the MPU-Series LightClock, a family of high-performance optical clocks for next generation microprocessors. LightClock represents a true mpu clocking paradigm shift. It offers a fully scalable clocking technology that substantially reduces mpu power consumption and jitter while generating a high-frequency signal which can be distributed between and within multiple cores/chips. These high GHz frequencies can be distributed via free space or waveguides without the many problems associated with transmission in scaled or non-scaled copper wire, especially over the longer distances between multiple cores/chips. The MPU-Series LightClock is a semiconductor pulsed laser based on proprietary LightTime laser design expertise. With a timed photonic signal output, LightClock enables the architecture and performance advances needed for the roadmap of next generation mpu's.



#### **IMMEDIATE BENEFITS FROM AN ENTIRELY NEW TECHNOLOGY**

**Completely Scalable:** **Speed:** LightClocks can be produced with pulse repetition rates from 8 GHz to over 160 GHz. **Distribution:** The optical signal can be split into many paths.

**Reduced Power Consumption:** Net savings on the order of 10% of the total mpu power consumption are expected mainly from savings in the optical signals distribution. It also eliminates the need for PLLs, which means additional mpu power and heat savings are realized.

**Decreased Jitter:** LightClocks reduce jitter in at least two ways: a) because high pulse rates are the LightClocks' native mode of oscillation, signals can be distributed directly which eliminates frequency multipliers and transmission buffers vulnerable to voltage fluctuations, and b) for chip-level applications, the LightClocks' rise times are an order of magnitude faster than those of the gate outputs, reducing the relative uncertainty in edge rates. Further, LightClocks are inherently stable and have been demonstrated to only have about 1 ps RMS of jitter.

**Simplified Skew Management:** Delays are decreased and the LightClocks' photonic signal time-of-arrival can be easily controlled by design.

**No Added EMI / RFI Issues:** As an entirely optical signal, LightClocks neither produce nor are vulnerable to the EMI / RFI issues associated with electronic signal transmission.

**Economical:** As semiconductor devices, LightClocks are economically mass-produced.

**Versatile Physical Interface:** LightClocks can interface with customer systems in a variety of customer-preferred formats including flipchip, TO/butterfly package, fiberoptic pigtail, or via other methods.

## SUMMARY PERFORMANCE CHARACTERISTICS

**Wavelength:** Wavelengths from about 700 to 1600 nm are possible.

**Pulse Repetition Rate:** Frequencies from 8 to over 160 GHz are possible.

**Average Output Power:** Present designs: CW Avg. > 40 mW with a peak power over 160 mW.

**Modelocking Mechanism:** Proprietary semiconductor laser technology.

**Tuning Range:** LightClocks are fixed wavelength devices that can be "fine-tuned" to specific frequencies via two possible methods:

a) For high-volume applications, LightClocks can be fabricated at specific frequencies, for example, 19.9, 20.0, or 20.1 GHz. Then, each laser can be kept within a frequency variation of <0.05 GHz of its design using a TEC (temperature). Thus, a 20.1 GHz output signal could vary maximally from 20.05 to 20.15 GHz.

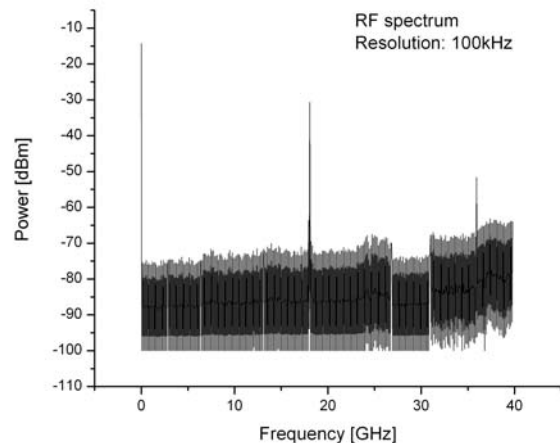
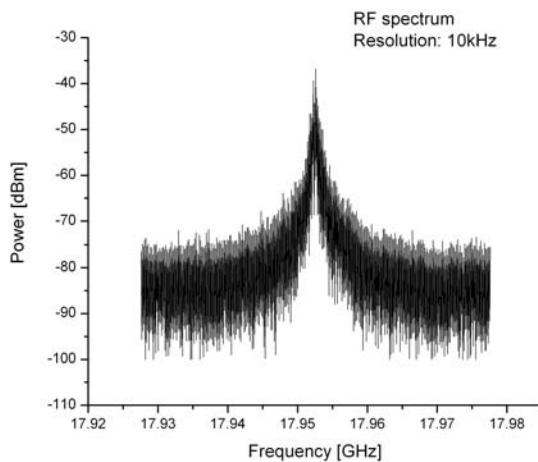
b) On an individual unit basis, a LightClock's repetition rate can be adjusted within approximately  $\pm 5\%$  of its center repetition rate by adjusting the TEC.

**Pulse Width:** approximately 25% of the period (e.g., 25 ps for 10 GHz, 6 ps for 40 GHz).

**Rise/Fall Time:** < 30% of the pulse width.

**Jitter:** about 1 ps RMS.

**RF Spectrum:** The following traces show sample low and high resolution RF power spectrum graphs for an 18 GHz LightClock. The signal peak is over 40 dB above the noise floor and at -10 dB the peak width is <1 MHz.



LightTime welcomes interested parties to learn more details about LightClocks after entering into a non-disclosure agreement.

All Specifications Subject To Change Without Notice