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| Name(s): | **Peter Cash** |
| Title(s): | Director of Space, Defense and Avionics |
| Company/ Organization Name: | Microsemi |

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| Paper Title: | **Satellite Timing Modules** |

Abstract:

Precision ovenized quartz oscillators are used in many applications that require precision timing, communication, measurement and navigation. The high stability quartz crystals used in these oscillators have intrinsic accuracy limitations and frequency drift (aging.) These effects require the external adjustment of quartz oscillators or in some cases the use of on-board atomic clocks. The system complexity of these options, as well as cost, is a deterrent to providing the necessary performance for many satellites. Utilizing an externally generated one pulse per second ( 1 PPS) signal available from on-board Global Positioning Receivers ( GPS) or alternatively other satellites within a constellation to adjust the frequency of the quartz oscillator. This approach reduces the system complexity and provides frequency and timing accuracy, and the ability to distribute timing throughout the satellite.

One pulse per second steering of quartz oscillators is a common technique in terrestrial applications, however the radiation environment in space places requirements on the FPGAs required for frequency steering of the crystal oscillator. Microsemi's Space Defense and Avionic group in Beverly Massachusetts has experience using multiple supplier's FPGAs for space frequency sources.

Microsemi has an extensive legacy of precision ovenized quartz oscillators and has developed and delivered oscillators capable of external steering via a 1 PPS input. These oscillators use Kalman Filtering to optimally steer the quartz oscillators for both short term and long term frequency stability. This paper will describe the development and testing of these modules, along with future applications.