Active Project (2014 - 2016)

Extreme Environment Circuit Blocks for Spacecraft Power & Propulsion System & Other High Reliability Applications, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Chronos Technology (Dlv of FMI, Inc.) proposes to design, fabricate, and deliver a performance proven, and commercially available set of extreme high operating temperature PWM controller and circuit blocks (EXTEC1). These rad-hard (TID, SEU, ELDERS) components are intended to be used in a variety of spacecraft power and propulsion systems (PPU) along with smart power sub-assemblies for a wide range of both manned and unmanned space missions and payloads. The resulting devices would meet and exceed the required performance under extreme environment, high temperature while being offered commercially in very light, small and rugged package sizes and footprints. The described performance would be superior to any present-day alternatives that may only be available at much lower operating temperatures with no provisions for radiation hardness. The proposed range of circuit blocks that will be fabricated in Silicon Carbide (SiC) technology includes monolithic Pulse Width Modulator (PWM) controller as well as basic circuit blocks such as logic gate(s), counter(s), multivibrator, ramp generator, voltage reference, oscillator, buffer(s) and driver circuits. Logically and synergistically, many of the aforementioned circuit blocks would be used in the integrated PWM design.The significant points of innovation that we propose to bring to realization are: 1-Design and fabrication of a SiC MSI (medium-scale integration) Mixed-Signal ASIC. The proposed PWM controller ASIC is a mixed-signal system. 2-Design and fabrication of a precision, high-temperature capable, voltage reference on SiC at the integrated circuit level (used in the PWM and other applications). 3-Design and fabrication of precision, extreme high-temperature capable, timing circuits on SiC at the integrated circuit level (used in the PWM and other applications). 4-Common approach to the yield packaged extreme environment component encapsulation among the various devices designed and fabricated in the project

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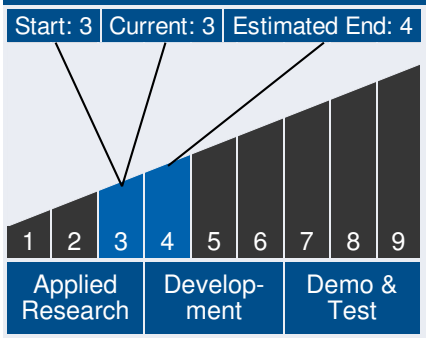
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Spacecraft power and propulsion (PPU) system requirements as well as other related smart power module applications is the main driver behind this proposal. A number of NASA centers have been working on such applications. Published work such as the recent paper by NASA Kennedy space center, Langley Research Center and JPL (IEEE 978-1-4673-1813-6/13) captures the closest perspective to the needed innovation for solar electric propulsion. Given that most of the attention is taken on the high power side of the utilized circuit blocks, the proposed work here would offer the best match to meet and exceed the NASA objectives. In parallel with offering response to meet the PPU demand, other future NASA mission targets with some emphasis on "hot planets" could be well served not only by the integrated PWM controller but also the standalone circuit blocks could play pivotal role in mitigating the challenges for electronic circuit operation at extreme high temperatures and in small form-factors. pulse width modulator (PWM) controller could be used in smart power (inverter/converter) applications in NASA missions with diverse base of power generation and distribution schemes. Missions to hot planets, atmospheric probes, deep space missions and any missions requiring space propulsion cover the potential application base for the PWM controller. The standalone devices will have additional application in motor controllers, timers and stable clocks in extreme high temperature environments

To the commercial space industry:

Potential Non-NASA Commercial Applications: The potential non-NASA applications are divided into non-NASA space applications on the one side while other avionics, jet engine controller, down-hole and various advanced "all electrical" vehicle for defense and other industrial automotive applications would round up the segment. The non-NASA space applications

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

Project Manager:
- Yuan Chen

Principal Investigator:
- Kouros Sariri

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
- Power Management and Distribution (TA 3.3)
  - Distribution and Transmission (TA 3.3.3)
    - High-Temperature Semiconductors, Passive Components, and Interconnects (TA 3.3.3.5)

Secondary Technology Area:
In-Space Propulsion Technologies (TA 2)
- Non-Chemical Propulsion (TA 2.2)
  - Electric Propulsion (TA 2.2.1)

Additional Technology Areas:
Space Power and Energy Storage (TA 3)
- Power Management and Distribution (TA 3.3)

would follow the NASA applications closely. The variety of DC-DC converters and solar power inverters are quite common examples. Our direct market observations and discussions indicate that there are a variety of smart power module designs for commercial space and non-NASA scientific space applications that would benefit from the availability of reliable and radiation hardened PWM controllers for power inverter applications. The potential market segments within the non-radiation hardened area are rather diversified. Down-hole oil and gas exploration and geothermal energy generation represent a serious market for the PWM controller. FMI has received very positive written statements of interest from the leading companies in that industry. FMI has already made efforts at the prototype level for timing control applications in the jet engine control market segment. It is a logical approach to leverage such effort to introduce the performance results of the proposed SiC devices to the jet engine control market. Electric vehicle applications could be another potential for the developed devices. This includes the DOD's next generation, all electrical combat vehicle.

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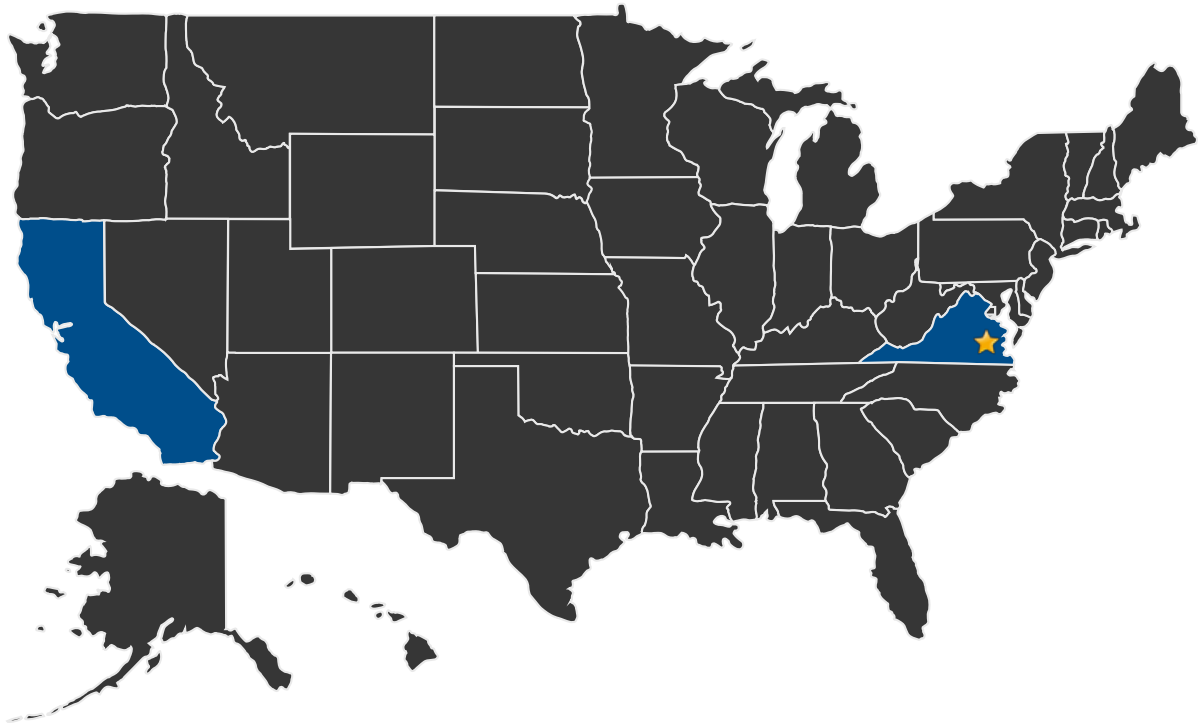
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Langley Research Center

Other Organizations Performing Work:

- Chronos Technology (Div. of FMI, Inc.) (Huntington Beach, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/20274)

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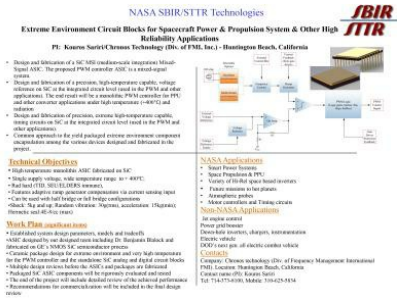
IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

Extreme Environment Circuit Blocks for Spacecraft Power & Propulsion System & Other High Reliability Applications