
Versatile Controller for Infrared Lamp and Heater Arrays

NASA's Jet Propulsion Laboratory, Pasadena, California

A paper describes a modular design for new controllers for infrared heating during cruise stage solar thermal vacuum test of the Mars Science Laboratory. The controllers had to be easy to use and maintain, used with a wide variety of different control schemes, and made using commercial off-the-shelf (COTS) components wherever possible.

A new controller was designed and built using COTS components that could be operated manually, or automatically in a temperature control mode through the use of programmable PID (proportional-integral-deriva-

tive) controllers. Another option is through computer control to implement control schemes involving average over a number of sensors, with no sensor above or below the temperature set point or use of non-thermocouple sensors such as PRTs (platinum resistance thermometer), calorimeters, etc. The system incorporates a thermal failsafe to guard against high-temperature overruns of the test item, ground fault circuit interrupters for personal protection, and has provision for an external shutdown signal for other conditions such as a vacuum system entering the

corona region with the addition of a proper alarm system.

This controller was designed and built as a versatile general-purpose controller. Its modular design will make upgrades or modifications simple to implement. Previous controllers used at JPL were purpose-built for the project that required them, and difficult to upgrade or modify.

This work was done by Michael R. McKee, Isaac M. Brown, Seth L. Chazanoff, and Bruce Woodward of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47402

High-Speed Scanning Interferometer Using CMOS Image Sensor and FPGA Based on Multifrequency Phase-Tracking Detection

Applications include LCD/plasma display inspection and semiconductor wafer process characterization.

Goddard Space Flight Center, Greenbelt, Maryland

A sub-aperture stitching optical interferometer can provide a cost-effective solution for an *in situ* metrology tool for large optics; however, the currently available technologies are not suitable for high-speed and real-time continuous scan. NanoWave's SPPE (Scanning Probe Position Encoder) has been proven to exhibit excellent stability and sub-nanometer precision with a large dynamic range. This same technology can transform many optical interferometers into real-time subnanometer precision tools with only minor modification.

The proposed field-programmable gate array (FPGA) signal processing concept, coupled with a new-generation, high-speed, mega-pixel CMOS (comple-

mentary metal-oxide semiconductor) image sensor, enables high speed (>1 m/s) and real-time continuous surface profiling that is insensitive to variation of pixel sensitivity and/or optical transmission/reflection. This is especially useful for large optics surface profiling.

Due to the patented phase synchronous tracking detection scheme in the time domain, the new method has already demonstrated better than 65 pm rms measurement noise (from single-pixel information alone) using an experimental setup, while up to 60 pm dynamic phase accuracy over the entire measurement range is predicted. Simulation shows that the measurement noise level could reach 1–2 pm.

It also correctly maps the phase even when high-density fringe is present under faint light condition (similar to lock-in amplifier). The real-time scanning also provides sub-pixel spatial resolution. This new technology is capable of measuring steep wall objects or aspheres with more than a few hundred waves of aspheric departure without the use of dedicated null lenses or computer-generated holograms. Thus, a compact, scalable, low-cost and low-energy consumption system can be achieved.

This work was done by Tetsuo Ohara of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15942-1

Ultra-Low-Power MEMS Selective Gas Sensors

Sensor uses 10 to 1,000 times less power than current commercial sensors.

John H. Glenn Research Center, Cleveland, Ohio

This innovation is a system for gas sensing that includes an ultra-low-power MEMS (microelectromechanical system) gas sensor, combined with

unique electronic circuitry and a proprietary algorithm for operating the sensor. The electronics were created from scratch, and represent a novel de-

sign capable of low-power operation of the proprietary MEMS gas sensor platform. The algorithm is used to identify a specific target gas in a gas mixture,

making the sensor selective to that target gas.

The objectives achieved include the development of an ultra-low-power, low-cost, high-performance, selective MEMS gas sensor for cryogenic and energy gases, such as H₂, He, CH₄, and CO₂. This product will have unique competitive advantages over current offerings because it uses 10 to 1,000 times less power than current commercial sensors, enabling low-cost distributed sensing in a wide variety of NASA and private sector applications. This sensor is also highly reliable, ultra-stable, and selective to single gases in mixtures, creating a combination of features that cannot be matched with other state-of-the-art technologies. Many proprietary and non-pro-

prietary gas sensor technologies exist to monitor energy gases, each with their own advantages and disadvantages. However, none of these technologies or methods operates at the low power of this MEMS gas sensor, with selectivity, long-term stability, and reliability over a long period of time.

Novel and unique features include the new nano-TCD sensor platform; ultra-low-power operation (<10 nanowatt per reading), fast response (measured in nanoseconds, >1,000 times faster than current devices, and stability through tens of billions of measurements and over environmental temperature and RH ranges, and calibration stability for >5 years with no consumables and unprecedented selectivity. The pro-

prietary software is original and does not reuse existing code, shareware, or code owned by a non-federal entity. The algorithm developed is the novel element added to the patented nano-TCD structure and is proprietary.

This work was done by Joseph Stetter of KWJ Engineering, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18831-1.