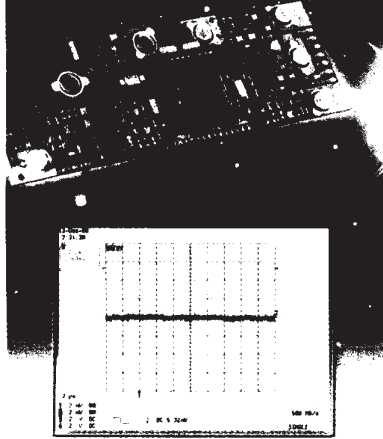


# Satellite Power Design Simplified

## Mx Series Platform



The MA & MB series of triple output DC-DC converter design platforms offers low noise power performance in an open board assembly construction for sensitive RF equipment onboard spacecraft.

### FEATURES

- Bus Voltage Range: 20 to 100V<sub>DC</sub>
- Two Power Levels:  
MA at 5W, MB at 15W
- Triple Output: Each can be configured from 3.3V to 15V
- Low Output Noise <1 mV<sub>RMS</sub>
- CS Rejection >95db

For more information call 1.800.919.7898  
or visit us at [www.irf.com/hirel](http://www.irf.com/hirel)

International  
Rectifier  
THE POWER MANAGEMENT LEADER

Free Info at <http://info.hotims.com/15128-729>



## Electronics/Computers

### Using Transponders on the Moon to Increase Accuracy of GPS

Ranging to the Moon would be unaffected by the terrestrial atmosphere.

*NASA's Jet Propulsion Laboratory, Pasadena, California*

It has been proposed to place laser or radio transponders at suitably chosen locations on the Moon to increase the accuracy achievable using the Global Positioning System (GPS) or other satellite-based positioning system. The accuracy of GPS position measurements depends on the accuracy of determination of the ephemerides of the GPS satellites. These ephemerides are determined by means of ranging to and from Earth-based stations and consistency checks among the satellites. Unfortunately, ranging to and from Earth is subject to errors caused by atmospheric effects, notably including unpredictable variations in refraction.

The proposal is based on exploitation of the fact that ranging between a GPS satellite and another object outside the atmosphere is not subject to error-inducing atmospheric effects. The Moon is such an object and is a convenient place for a ranging station. The ephemeris of the Moon is well known and, unlike a GPS satellite, the Moon is massive enough that its orbit is not measurably affected by the solar wind and solar radiation.

According to the proposal, each GPS satellite would repeatedly send a short laser or radio pulse toward the Moon and the transponder(s) would respond by sending back a pulse and delay information. The GPS satellite could then compute its distance from the known position(s) of the transponder(s) on the Moon.

Because the same hemisphere of the Moon faces the Earth continuously, any transponders placed there would remain continuously or nearly continuously accessible to GPS satellites, and so only a relatively small number of transponders would be needed to provide continuous coverage. Assuming that the transponders would depend on solar power, it would be desirable to use at least two transponders, placed at diametrically opposite points on the edges of the Moon disk as seen from Earth, so that all or most of the time, at least one of them would be in sunlight.

*This work was done by Konstantin Penanen and Talso Chui of Caltech for NASA's Jet Propulsion Laboratory. For further information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov). NPO-43160*

### Controller for Driving a Piezoelectric Actuator at Resonance

Unpredictable variations in resonance frequency are tracked.

*NASA's Jet Propulsion Laboratory, Pasadena, California*

A digital control system based partly on an extremum-seeking control algorithm tracks the changing resonance frequency of a piezoelectric actuator or an electrically similar electromechanical device that is driven by a sinusoidal excitation signal and is required to be maintained at or near resonance in the presence of uncertain, changing external loads and disturbances.

Somewhat more specifically, on the basis of measurements of the performance of the actuator, this system repeatedly estimates the resonance frequency and alters the excitation frequency as needed to keep it at or near the resonance frequency. In the original application for which this controller was developed, the piezoelectric actuator is part of an ultrasonic/sonic

[www.techbriefs.com](http://www.techbriefs.com)

NASA Tech Briefs, April 2008

drill/corer. Going beyond this application, the underlying principles of design and operation are generally applicable to tracking changing resonance frequencies of heavily perturbed harmonic oscillators.

Resonance-frequency-tracking analog electronic circuits are commercially available, but are not adequate for the present purpose for several reasons:

- The input/output characteristics of analog circuits tend to drift, often necessitating recalibration, especially whenever the same controller is used in driving a different resonator.

- In the case of an actuator in a system that has multiple modes characterized by different resonance frequencies, an analog controller can tune erroneously to one of the higher-frequency modes.

- The lack of programmability of analog controllers is problematic when faults occur, and is especially problematic for preventing tuning to a higher-frequency mode.

In contrast, a digital controller can be programmed to restrict itself to a specified frequency range and to maintain

stability even when the affected resonator is driven at high power and subjected to uncertain disturbances and variable loads.

The present digital control system (see figure) is implemented by means of an algorithm that comprises three main sub-algorithms: a hill-climbing control algorithm, an estimation-based extremum-seeking control (ESC) algorithm, and a supervisory algorithm. The hill-climbing algorithm is useful for coarse tracking to find and remain within the vicinity of the resonance. The ESC algorithm is not capable of coarse resonance tracking, but is capable of fine resonance tracking once the estimates of parameters generated by the hill-climbing algorithm have converged sufficiently. On the basis of the parameter-estimation errors, the supervisory algorithm switches operation to whichever of the other two algorithms performs best at a given time.

For the purpose of the control algorithm, the performance of the actuator is quantified in terms of the ratio between the time-averaged drive-voltage amplitude and the time-averaged drive current amplitude during a sampling time period. In the hill-climbing algorithm, the excitation frequency during the next sampling period is incremented or decremented by an arbitrary fixed step. If the increment or decrement results in an increase in the current/voltage ratio, then the direction of change (increase or decrease, respectively) of frequency is accepted and another such change (increment or decrement, respectively) is made during the following sampling period. If, on the other hand, the increment or decrement results in a decrease in the current/voltage ratio, then the direction of change of frequency during the following sampling period is reversed. The process as described thus far is repeated, causing the current/voltage performance to climb to one of the resonance peaks and eventually to oscillate about the peak. In order to prevent climbing of one of the undesired higher-frequency resonance peaks, it is necessary to choose the starting excitation frequency near the desired peak and to impose a limit on the excursion from the starting frequency.

Once the excitation frequency has begun to oscillate about the peak, the supervisory algorithm switches operation to the ESC algorithm, which uses past as well as present input/output data to make a least-squares estimate of the resonance frequency. The estimation task involves

## Extreme performance across the board.

### NEW! TC2D64™ (Intel Core 2 Duo-based VME SBC)

- 1.5 GHz and 2.16 GHz Intel® Core™ 2 Duo Processors
- Up to 4 GB ECC SDRAM Memory
- CompactFlash
- Two Gigabit Ethernet ports
- Two SATA ports
- Up to four PMC slots
- On board graphics controller
- Four USB and four serial ports
- Solaris™ 10, Linux™ and Windows™ support
- Up to 30G shock



### NEW! TPA-XMC™ (PrPMC/PrXMC module)

- PA Semi PA6T-1682M dual core 2.0GHz Processor
- 1 or 2 GB of DDR2-400 ECC SDRAM Memory
- 128 MB of OS Kernel NAND Flash Memory
- PCI Express I/O
- 4 GB Ethernet
- Two 10 GB Ethernet
- Support for Linux OS and VXworks
- Up to 30G shock



When the highest performance is critical to your mission, turn to Themis SBCs.

In mission critical applications, there's no substitute for high performance. The Themis family of single board computers includes dual-core, 64-bit AMD™, Intel and PA Semi processors in addition to our leading UltraSPARC products on VME and CompactPCI. So we can support applications in Solaris, Windows, Linux and UNIX.

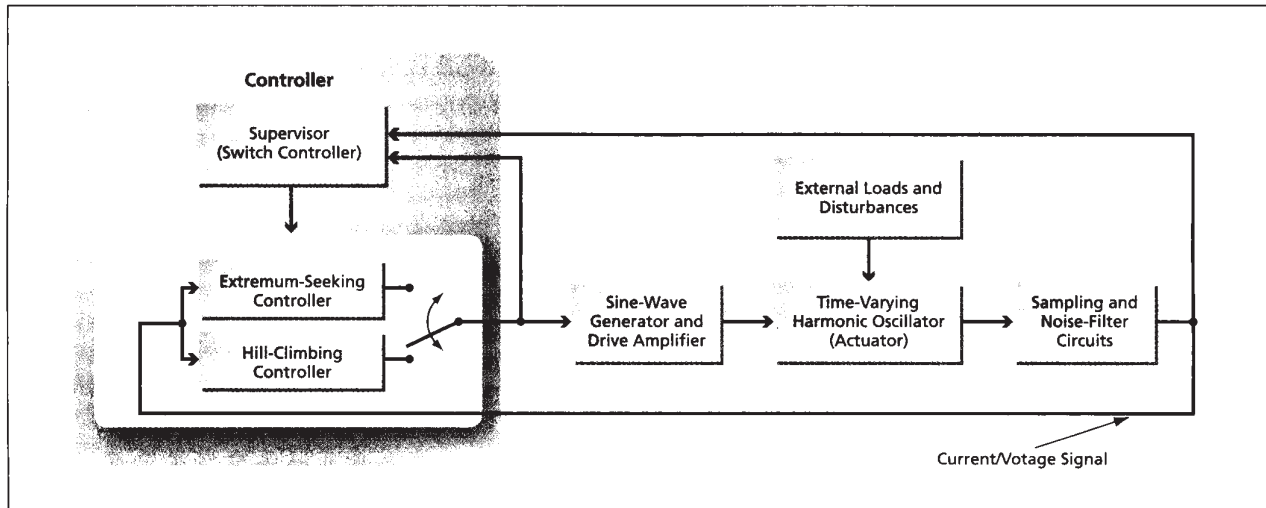
All Themis products offer maximum configuration flexibility and life cycle support for your technology refresh cycle process, reducing your Total Cost of Ownership.

So when mission success depends on higher performance, you can rely on Themis. Across the board.

www.themis.com (510) 252-0870

**THEMIS**

Transformational.



This **Resonance-Tracking Controller** includes three main subsystems that function together to effect a combination of coarse and fine frequency tracking optimized to maintain operation at a desired resonance and avoid undesired resonances.

updating two scalar parameters of a quadratic model that represents the input/output map of the actuator resonance. After each sampling period, the new input/output data pair is added to the collection of past data pairs, such that information regarding the input/output relationship of the actuator increases over time; in other words, as the input/output information

comes in, the algorithm tries to improve the fit between the quadratic model near resonance and all the past input/output data up to the current time. Once the estimated parameters have converged sufficiently, the excitation frequency is updated according to a simple formula that represents a maximizer associated with the quadratic model. In the event that the estimates

begin to diverge beyond a specified limit, the supervisory algorithm switches operation back to the hill-climbing algorithm.

*This work was done by Jack Aldrich, Yoseph Bar-Cohen, Stewart Sherrit, Mircea Badescu, Xiaoqi Bao, and Zensheu Chang of Caltech for NASA's Jet Propulsion Laboratory. For further information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov). NPO-43519*

## Sometimes, you have to outrun the competition

VersaLogic's Cheetah Single Board Computer (SBC) delivers swiftness and agility to embedded computing applications. This Pentium® M PC/104-Plus product makes good on its promise of providing high-performance in a compact, ruggedized package. The Cheetah offers flexible RAM options and scalable processing for optimum application performance with minimal power draw. Available in standard (0° to +60°C) and extended (-40° to +85°C) temperature versions, the Cheetah features 10/100 Ethernet, high performance video capabilities, on-board CompactFlash® socket and extensive integrated I/O. Customization is available on quantities of 100 pieces or more.

Contact us and discover how for more than 30 years we've been perfecting the fine art of extra-ordinary support, and on-time delivery:

One customer at a time.

1.800.824.3163  
1.541.485.8575  
[www.versalogic.com/che](http://www.versalogic.com/che)

