



Long-Range Emergency Preemption of Traffic Lights

Addition of a forwarding system could improve preemption performance.

NASA's Jet Propulsion Laboratory, Pasadena, California

A forwarding system could prove beneficial as an addition to an electronic communication-and-control system that automatically modifies the switching of traffic lights to give priority to emergency vehicles. A system to which the forwarding system could be added could be any of a variety of emergency traffic-signal-preemption systems: these include systems now used in some municipalities as well as advanced developmental systems described in several NASA Tech Briefs articles in recent years.

Because of a variety of physical and design limitations, emergency traffic-signal-preemption systems now in use are often limited in range to only one intersection at a time: in a typical system, only the next, closest intersection is preempted for an emergency vehicle. Simulations of gridlock have shown that such systems offer minimal advantages and can even cause additional delays.

In analogy to what happens in fluid dynamics, the forwarding system insures that flow at a given location is sustained by guaranteeing downstream flow along the predicted route (typically a main artery) and intersecting routes (typically, side streets). In simplest terms, the forwarding system starts by taking note of any preemption issued by the preemption system to which it has been added. The forwarding system predicts which other intersections could be encountered by the emergency vehicle downstream of the newly preempted intersection. The system then forwards preemption triggers to those intersections.

Beyond affording a right of way for the emergency vehicle at every intersection that lies ahead along any likely route from the current position of the vehicle, the forwarding system also affords the benefit of clearing congested roads far ahead of the vehicle. In a metropolitan

environment with heavy road traffic, forwarding of preemption triggers could greatly enhance the performance of a pre-existing preemption system.

This work was done by Aaron Bachelder of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

*Innovative Technology Assets Management
JPL*

Mail Stop 202-233

4800 Oak Grove Drive

Pasadena, CA 91109-8099

(818) 354-2240

E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-40492, volume and number of this NASA Tech Briefs issue, and the page number.

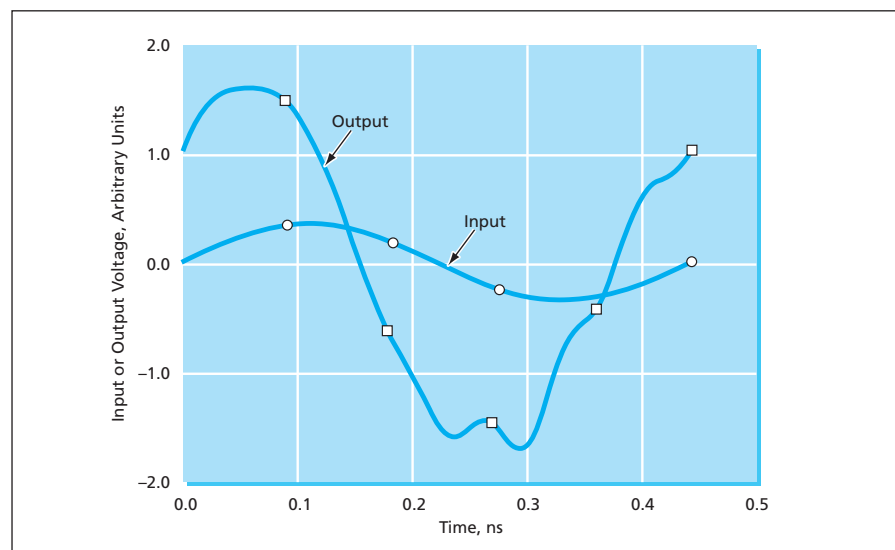
High-Efficiency Microwave Power Amplifier

High efficiency is achieved through class-D operation.

Marshall Space Flight Center, Alabama

A high-efficiency power amplifier that operates in the S band (frequencies of the order of a few gigahertz) utilizes transistors operating under class-D bias and excitation conditions. Class-D operation has been utilized at lower frequencies, but, until now, has not been exploited in the S band.

Nominally, in class D operation, a transistor is switched rapidly between "on" and "off" states so that at any given instant, it sustains either high current or high voltage, but not both at the same time. In the ideal case of zero "on" resistance, infinite "off" resistance, zero inductance and capacitance, and perfect switching, the output signal would be a perfect square wave. Relative to the traditional classes A, B, and C of amplifier operation, class D offers the potential to achieve greater power efficiency. In addition, relative to class-A amplifiers, class-D



The **Output Waveform** of the amplifier is of an intermediate form achieved in an effort to obtain a square-wave output from a sinusoidal input.

Measurement	Input Stage	Driver Stage	Final Stage
Input Voltage Standing-Wave Ratio	1.0023:1	1.9:1	33:1
Gain, dB	13.3	8.8	9.6
DC-to-RF Efficiency, Percent	54.2	42.6	58.6
Power-Added Efficiency, Percent	51.7	36.9	52.2

Several Measurements were made on each amplifier stage to characterize its performance.

amplifiers are less likely to go into oscillation.

In order to design this amplifier, it was necessary to derive mathematical models of microwave power transistors for incorporation into a larger mathe-

tical model for computational simulation of the operation of a class-D microwave amplifier. The design incorporates state-of-the-art switching techniques applicable only in the microwave frequency range. Another major novel

feature is a transmission-line power splitter/combiner designed with the help of phasing techniques to enable an approximation of a square-wave signal (which is inherently a wideband signal) to propagate through what would, if designed in a more traditional manner, behave as a more severely band-limited device (see figure).

The amplifier includes an input, a driver, and a final stage. Each stage contains a pair of GaAs-based field-effect transistors biased in class D. The input signal can range from -10 to +10 dBm into a 50-ohm load. The table summarizes the performances of the three stages.

This work was done by William H. Sims of Marshall Space Flight Center.

This invention has been patented by NASA (U.S. Patent No. 6,388,512). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.a.nabors@nasa.gov. Refer to MFS-31455.

Improvements of ModalMax High-Fidelity Piezoelectric Audio Device

Langley Research Center, Hampton, Virginia

ModalMax audio speakers have been enhanced by innovative means of tailoring the vibration response of thin piezoelectric plates to produce a high-fidelity audio response. The ModalMax audio speakers are 1 mm in thickness. The device completely supplants the need to have a separate driver and speaker cone. ModalMax speakers can perform the same applications of cone speakers, but unlike cone speakers, ModalMax speakers can function in harsh environ-

ments such as high humidity or extreme wetness. New design features allow the speakers to be completely submerged in salt water, making them well suited for maritime applications. The sound produced from the ModalMax audio speakers has sound spatial resolution that is readily discernable for headset users. [The ModalMax product line was described in "High-Fidelity Piezoelectric Audio Device" (LAR-15959), *NASA Tech Briefs*, Vol. 27, No. 8 (August

2003), page 36.] Other improvements of the ModalMax audio speakers include methods to reduce size, reduce power demand, and increase audio fidelity by increasing vibrational responses at the low and high ends of the audio frequency range.

This work was done by Stanley E. Woodard of Langley Research Center. Further information is contained in a TSP (see page 1). LAR-16321-1

Alumina or Semiconductor Ribbon Waveguides at 30 to 1,000 GHz

The waveguides would be configured to exploit low-loss electromagnetic modes.

NASA's Jet Propulsion Laboratory, Pasadena, California

Ribbon waveguides made of alumina or of semiconductors (Si, InP, or GaAs) have been proposed as low-loss transmission lines for coupling electronic components and circuits that operate at frequencies from 30 to 1,000 GHz. In addition to low losses (and a concomi-

tant ability to withstand power levels higher than would otherwise be possible), the proposed ribbon waveguides would offer the advantage of compatibility with the materials and structures now commonly incorporated into integrated circuits.

Heretofore, low-loss transmission lines for this frequency range have been unknown, making it necessary to resort to designs that, variously, place circuits and components to be coupled in proximity of each other and/or provide for coupling via free space through bulky