brator's speaker is mounted at one end of a 14-cm-long and 4.1-cm diameter small plane-wave tube. This length was chosen so that the first evanescent cross mode of the plane-wave tube would be attenuated by about 90 dB, thus leaving just the plane wave at the termination plane of the tube. The tube terminates with a small, acrylic plate with five holes placed symmetrically about the axis of the speaker. Four ports are included for the four microphones on the probe. The fifth port is included for the pre-calibrated reference microphone.

The ports in the acrylic plate are in turn connected to the probe sensing elements via flexible PVC tubes. These five tubes are the same length, so the acoustic wave effects are the same in each tube. The flexible nature of the tubes allows them to be positioned so that each tube terminates at one of the microphones of the energy density probe, which is mounted in the acrylic structure, or the calibrated reference microphone. Tests performed verify that the pressure did not vary due to bends in the tubes. The results of these tests indicate that the average sound pressure level in the tubes varied by only 0.03 dB as the tubes were bent to various angles.

The current calibrator design is effective up to a frequency of approximately 4.5 kHz. This upper design frequency is largely due to the diameter of the plane-wave tubes.

This work was done by Scott D. Sommerfeldt and Jonathan D. Blotter of Brigham Young University for Stennis Space Center.

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Refer to SSC-00248, volume and number of this NASA Tech Briefs *issue, and the page number.*

Four-Way Ka-Band Power Combiner

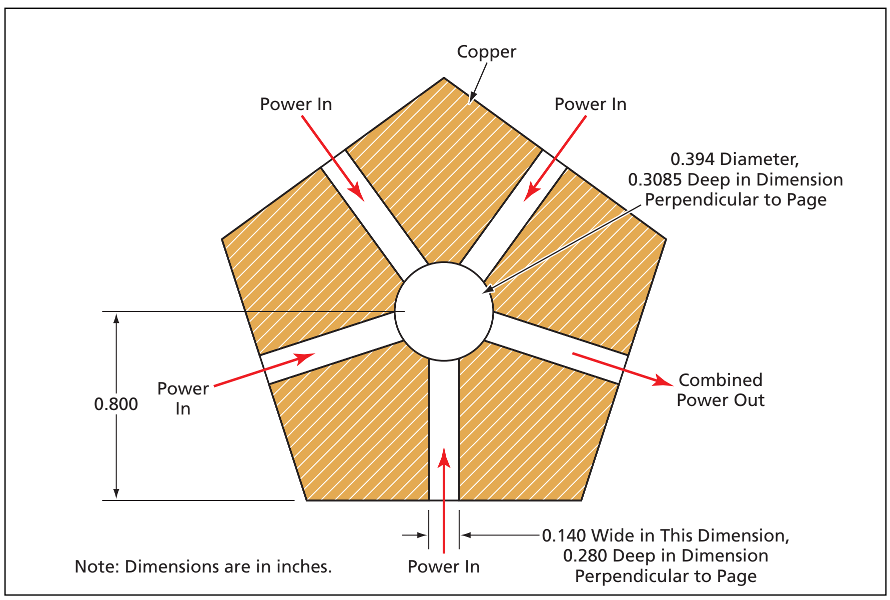
A prior X-band design has been adapted to Ka band.

NASA's Jet Propulsion Laboratory, Pasadena, California

A waveguide structure for combining the outputs of four amplifiers operating at 35 GHz (Ka band) is based on a similar prior structure used in the X band. The structure is designed to function with low combining loss and low total reflected power at a center frequency of 35 GHz with a 160 MHz bandwidth.

The structure (see figure) comprises mainly a junction of five rectangular waveguides in a radial waveguide. The outputs of the four amplifiers can be coupled in through any four of the five waveguide ports. Provided that these four signals are properly phased, they combine and come out through the fifth waveguide port.

This work was done by Raul Perez and Samuel Li of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-41291



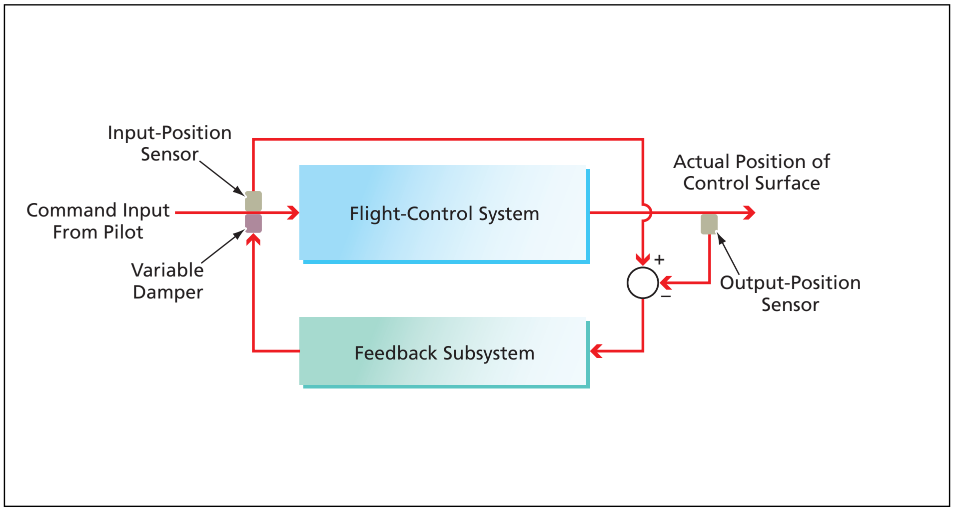
The **Power Combiner Structure** has five ports, of which four are used for input and one for output. This is a simplified cross-sectional view: holes for fastening and cooling are omitted for the sake of clarity.

Loss-of-Control-Inhibitor Systems for Aircraft

Excessive commands are resisted by feedback in the form of damping forces.

Langley Research Center, Hampton, Virginia

Systems to provide improved tactile feedback to aircraft pilots are being developed to help the pilots maintain harmony between their control actions and the positions of aircraft control surfaces, thereby helping to prevent loss of control. A system of this type, denoted a loss-of-control-inhibitor system (LOCIS) can be implemented as a relatively simple addition to almost any pre-existing flight-control system. The LOCIS concept offers at least a partial solution to the problem of (1) keeping a pilot aware of the state of the control system and the aircraft and (2) maintaining sufficient control under conditions that, as described below, have been known to lead to loss of control.



This **Simplified Block Diagram** represents a LOCIS added to a flight-control system that includes a single control surface.

Current commercial aircraft exhibit uneven responses of primary flight-control surfaces to aggressive pilot control commands, leading to deterioration of pilots' ability to control their aircraft. In severe cases, this phenomenon can result in loss of control and consequent loss of aircraft. For an older aircraft equipped with a purely mechanical control system, the loss of harmony between a pilot's command action and the control-surface response can be attributed to compliance in the control system (caused, for example, by stretching of control cables, flexing of push rods, or servo-valve distortion). In a newer aircraft equipped with a fly-by-wire control system, the major contributions to loss of harmony between the pilot and the control surfaces are delays attributable to computer cycle time, control shaping, filtering, aliasing, servo-valve distortion, and actuator rate limiting. In addition, a fly-by-wire control system provides no tactile feedback that would enable the pilot to sense such features of the control state as surface flutter, surface jam, position limiting, actuator rate limiting, and control limiting imposed by the aircraft operational envelope.

Hence, for example, when a pilot is involved in aggressive "closed-loop" maneuvering, as when encountering a wake-vortex upset on final landing approach, the control-surface delay can lead to loss of control. Aggressive piloting can be triggered and exacerbated by control-system anomalies, which the pilot cannot diagnose because of the lack of symptoms caused by the absence of feedback through the controls. The purpose served by a LOCIS is to counteract these adverse effects by providing real-time feedback that notifies the pilot that the aircraft is tending to lag the pilot's commands.

A LOCIS (see figure) includes cockpit control input-position sensors, control-surface output-position sensors, variable dampers (for example, shock absorbers containing magneto-rheological fluids such that the damping forces can be varied within times of the order of milliseconds by varying applied magnetic fields) attached to the cockpit control levers, electromagnet coils to apply the magnetic fields, and feedback control circuits to drive the electromagnet coils. The feedback control gains are chosen so that the current applied to each electromagnet coil results in a damping force that increases in a suitable nonlinear manner (e.g., exponentially) with the difference between the actual and commanded positions of the affected control surface. The increasing damping force both alerts the pilot to the onset of a potentially dangerous situation and resists the pilot's effort to command a control surface to change position at an excessive rate.

This work was done by Ralph C. A'Harrah of NASA Headquarters. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center, at (757) 864-3521. Refer to LAR-16566.

Improved Underwater Excitation-Emission Matrix Fluorometer

This is a higher-resolution, smaller, more-capable successor to a prior instrument.

Stennis Space Center, Mississippi

A compact, high-resolution, two-dimensional excitation-emission matrix fluorometer (EEMF) has been designed and built specifically for use in identifying and measuring the concentrations of organic compounds, including polluting hydrocarbons, in natural underwater settings. Heretofore, most EEMFs have been designed and built for installation in laboratories, where they are used to analyze the contents of samples collected in the field and brought to the laboratories. Because the present EEMF can be operated in the field, it is better suited to measurement of spatially and temporally varying concentrations of substances of interest.

In excitation-emission matrix (EEM) fluorometry, fluorescence is excited by irradiating a sample at one or more wavelengths, and the fluorescent emission from the sample is measured at multiple wavelengths. When excitation is provided at only one wavelength, the technique is termed one-dimensional (1D) EEM fluorometry because the resulting matrix of fluorescence emission data (the EEM) contains only one row or column. When excitation is provided at multiple wavelengths, the technique is termed two-dimensional (2D) EEM fluorometry because the resulting EEM contains multiple rows and columns.

EEM fluorometry — especially the 2D variety — is well established as a means of simultaneously detecting numerous dissolved and particulate compounds in water. Each compound or pool of compounds has a unique spectral fluorescence signature, and each EEM is rich in information