of 13 dB in the frequency range from 31.8 to 32.3 GHz.

The amplifiers would be identical to commercially available GaAs monolithic microwave integrated circuits (MMICs). Accompanying the QOPA, on the same circuit board, there would be two arrays of antenna elements: a drive array (a planar array of identical input antenna elements) and a transmitting array (a planar array of identical output antenna elements). The drive array would be fed via a hard horn, providing uniform illumination to each array element. By use of microstrip transmission lines, all of equal length, the input and output terminals of the MMIC amplifiers would be connected to the corresponding drive and transmitting antenna elements, respectively. This QOPA design would offer the following advantages (among others):

- The separation of the input and output drive arrays helps eliminate the problem, encountered in prior QOPA systems, of oscillation and allows the use of high-gain amplifiers.
- Unlike a TWTA, the MMIC amplifiers would not necessitate a high-voltage power supply.
- The array of MMIC amplifiers could be actively cooled from its back side; unlike in prior QOPA arrays, it would not be necessary to rely on edge cooling, which is less effective and thus limits the achievable power to a lower level. This is important for future inclusion of wide band-gap devices such as GaN.
- The failure of a single amplifier would not be catastrophic: as long as the other amplifiers continued to operate, the loss in performance would be relatively small. For maximum efficiency, the independent bias lines allow individual modules to be turned off as output power demands change.

The system would include a frequency-selective surface (essentially, a radio-frequency dichroic reflector) intended to reflect the transmitted beam while passing the received monopulse beam. The FSS would provide between 40 and 60 dB of isolation between the transmitted and received beams.

This work was done by Abdur Khan, Dan Hoppe, Larry Epp, and Raul Perez of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
NPO-30559

EMI Filters for Low-Temperature Applications

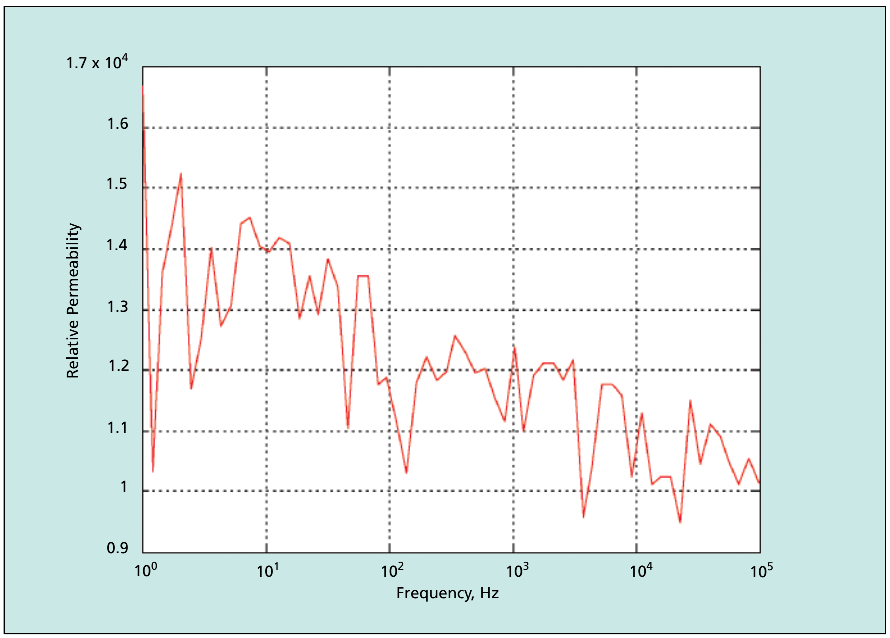
Unlike ferrite-core filters, these should work well under cryogenic conditions.

NASA's Jet Propulsion Laboratory, Pasadena, California

Filters that suppress electromagnetic interference (EMI) on signal cables connected to cryogenic electronic equipment can be made from cores consisting of high-permeability materials. The basic principle of operation of these filters is the same as that of the ferrite-core common-mode EMI filters now commonly used on cables that connect computers with peripheral equipment.

The ferrite-core filters are effective at room temperature but not at low temperatures, because their relative permeabilities decrease from ≈15,000 at room temperature to ≈20 at a temperature of 4 K. In cases of cables that connect cryogenic electronic equipment with room-temperature electronic equipment, it has been common practice to place the ferrite filters at the room-temperature ends of the cables. This makes it necessary for the filtered signals to traverse the cables; during such traversal, crosstalk with other cables can cause the filtered signals to become recontaminated with EMI before they reach the cryogenic equipment. Hence, it would be preferable to place the EMI filters at the cryogenic ends of the cables. The present development makes this a viable option.

An inductive EMI filters blocks EMI due to its impedance to high frequency EMI signals. Since the impedance is proportional to the permeability, a material with high permeability forms the core of such a filter. Several metallic alloys like Cryoperm 10 and VITROVAC are known to have relative permeability exceeding 14,000 at low temperature. However, their relative permeabilities decrease rapidly at frequencies higher than a few hundred hertz due to eddy current, which prevents the magnetic field from penetrating the material. Because ferrite is an insulator, eddy current is not present. Therefore it works at high frequencies. However, all known materials with high permeabilities at low temperatures are metallic. Therefore, for the purpose of constructing cores for low-temperature EMI filters, it is desirable to prepare the high-permeability materials in the form of thin foils or fine powders to reduce the effects of eddy currents. Preliminary



Relative Permeability was measured with a superconducting quantum interference device (SQUID) magnetometer at 4 K.

measurements and calculations have shown that when foil thicknesses or particle sizes are reduced to <25 μm, eddy currents become unimportant.

We have performed low-temperature test (see figure) of a cobalt-based magnetic material made by Honeywell called Meglas 2714A, which has very high permeability at room temperature and is available in form of tape-wound cores of various sizes. These cores are wound from 18-μm thick ribbons to reduce eddy current for high-frequency operations. The relative permeability is higher than 10,000 at frequencies up to 100 kHz, the limit of capability of our measurement. EMI filters made from this material should work at low temperature.

This work was done by Talso Chui and Hung Quach of Caltech for **NASA's Jet Propulsion Laboratory.** *Further information is contained in a TSP (see page 1).*
NPO-30901

Lightweight Electronic Camera for Research on Clouds

This camera would rapidly acquire image data on aerosol particles.

Goddard Space Flight Center, Greenbelt, Maryland

"Micro-CPI" (wherein "CPI" signifies "cloud-particle imager") is the name of a small, lightweight electronic camera that has been proposed for use in research on clouds. The Micro-CPI would be incorporated into a small autonomous or remotely piloted airplane of a type that is now used in meteorological research and that is capable of remaining aloft for times long enough (typically about 30 hours) to collect statistically significant sets of data.

According to a preliminary design, the Micro-CPI would have a mass <1.5 kg and would consume less than 7 W of electric power. It would acquire and digitize high-resolution (3-μm-pixel) images of ice particles and water drops at a rate up to 1,000 particles (and/or drops) per second. The Micro-CPI incorporates a particle detection laser that triggers the camera imaging laser, and also counts and sizes very small (<1-μm) aerosol particles and cloud drops up to about 100 μm in diameter. The Micro-CPI could record data for an observation time of more than 30 hours and could operate autonomously.

Although a quantitative estimate of the cost of the Micro-CPI is not yet available, it has been projected that the cost would be low, relative to the costs of cameras of conventional design that could offer the same imaging capabilities. This is fortunate because there could be a potential need in the coming years to launch hundreds or even thousands of small uninhabited aircraft carrying cameras of Micro-CPI design as part of an effort to measure properties of clouds on a global scale. There are also potential applications in the measurement of drop-size distributions in sprays, especially in the agricultural and painting industries.

This work was done by Paul Lawson of SPEC Inc. for **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*
GSC-14950-1

Pilot Weather Advisor System

Cockpit displays of weather affecting flight are updated every five minutes.

John H. Glenn Research Center, Cleveland, Ohio

The Pilot Weather Advisor (PWA) system is an automated satellite radio-broadcasting system that provides nearly real-time weather data to pilots of aircraft in flight anywhere in the continental United States. The system was designed to enhance safety in two distinct ways: First, the automated receipt of information would relieve the pilot of the time-consuming and distracting task of obtaining weather information via voice communication with ground stations. Second, the presentation of the information would be centered around a map format, thereby making the spatial and temporal relationships in the surrounding weather situation much easier to understand. Starting in the early 1990s, the PWA system was developed by ViGYAN, Inc., under the NASA SBIR program. The system recently became commercially viable and was sold to WSI, a leading provider of weather services in aviation. The system is now marketed under the brand name "WSI InFlight."

The PWA system includes a ground processor (see figure), wherein a computer running special-purpose software converts, compresses, and schedules the weather data. The compressed data are then transmitted through a ground station to a geosynchronous satellite, from whence they are broadcast to cover the continental United States. The signal is acquired by a light, low-drag antenna mounted on a subscriber's aircraft, and is then interpreted by an equally lightweight receiver. In the cockpit of each InFlight equipped aircraft, the data are processed, by use of other special-purpose software and hardware, into an easy-to-interpret graphical display. The display is presented on a portable or panel-mounted unit. The data, which include graphical meteorological aviation reports (METARs), terminal aerodrome forecasts (TAFs), and Next Generation Weather Radar (NEXRAD) images, as well as other weather products, are updated every five minutes.

Accessibility of the system to light general aviation was a design goal because such airplanes are more susceptible to changes in weather than are larger, higher-flying airplanes. The lightweight, low-drag nature of the PWA airborne components and the relatively low cost of acquiring and using the equipment make the PWA system affordable for incorporation into lower-cost single-engine airplanes, which constitute the largest segment of the aviation market. Hence,