



Technology Focus: Sensors

Active and Passive Hybrid Sensor

The sensor acquires active and passive measurements to map ocean winds.

Goddard Space Flight Center, Greenbelt, Maryland

A hybrid ocean wind sensor (HOWS) can map ocean vector wind in low to hurricane-level winds, and non-precipitating and precipitating conditions. It can acquire active and passive measurements through a single aperture at two wavelengths, two polarizations, and multiple incidence angles. Its low profile, compact geometry, and low power consumption permits installation on aircraft platforms, including high-altitude unmanned aerial vehicles (UAVs).

The primary innovation enabling both active and passive measurements through a single system, while allowing for beam scanning, is the separation of transmit and receive beam synthesis process. With this approach, the antenna comprises several linear arrays, each with its own transceiver. The key components to this system are the transceiver, antenna, and multi-channel digital receiver subsystems. The antenna design was described in "Low-Profile, Dual-Wavelength, Dual-Polarized Antenna" (GSC-15706), *NASA Tech Briefs*, Vol. 34, No. 1 (January 2010), p. 26.

A novel capability of this design is that each transceiver has an internal calibration loop that is interconnected with adjacent transceivers. This allows the relative phase of the waveform generators and LO (local oscillator) signals to be directly measured. With environmental

changes, the relative phase distribution can change, which potentially degrades the antenna pattern due to phase errors and biases. Direct measurement of the LO phase and transmit phase alleviates this problem.

The system will operate at C and Ku-bands with beams at 30° and 40° incidence. The retrieval processor will use the active and passive measurements to map the ocean vector wind with a pixel resolution of approximately 2x2 km. With a more than 100-MHz bandwidth, it can operate in a high-resolution mode to provide very high-resolution imagery.

The system design operates in two separate modes: transmission and reception. During transmission, the phase and amplitude distribution of the array are controlled through the transceivers. Every n -th transmission cycle, the internal calibration circuits are used to measure the relative phase and amplitude differences introduced by the circuits themselves so that these offsets can be accounted for in forming the transmitted beam pattern. During reception, the receivers amplify and down-convert the receive backscatter and observed scene emission. The digitized signals are sent to the digital receiver subsystem, which applies phase and amplitude weightings to form the desired receive antenna pat-

tern. The receiver circuit also contains a Dicke switch and noise diode circuit to implement Dicke-Hach mode receiver. The bandwidth of the antenna and receiver paths is large enough that the passive signal is filtered from the active signal so that both may be measured simultaneously.

HOWS is useful for monitoring surface winds during severe ocean storms. Search and rescue missions can benefit from both the imaging capabilities of this system as well as the retrieved products. Although this system is focused on ocean vector winds, its ability to collect dual-wavelength, dual-polarized active and passive measurements and image over a range of incidence angles in a conically scanning or fixed pointing mode has broad use for remote sensing and surveillance purposes. Potential uses other than wind applications include mapping land, snow, and ice features. Its capabilities also can aid in target or scene classification, as well as high-resolution imaging from airborne or ground surveillance applications.

This work was done by James R. Carswell of Remote Sensing Solutions, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15707-1

Quick-Response Thermal Actuator for Use as a Heat Switch

Thermal actuators have many applications in aerospace, automotive, and energy storage.

NASA's Jet Propulsion Laboratory, Pasadena, California

This work improves the performance of a heat switch, or a thermal actuator, by delivering heat to the actuator in a more efficient manner. The method uses a heat pipe as the plunger or plug instead of just using a solid piece of metal. The heat pipe could be one tailored for fast transient thermal response.

A heat switch/thermal actuator works by using the expansion of a paraf-

fin wax as it melts as a means of moving a piston/plug/plunger to perform a function. Typically, this function is to close a small gap and increase heat transfer across a boundary, but it also could be used to move a latch. These devices are usually slow, and the stroke of the piston/plunger is very small.

A device of this kind could replace the need for heat switches that require power to operate on a spacecraft in a safe-mode

condition. This device would require no power to operate except for the waste heat of the device it is protecting. It may also be used as an energy-harvesting device by using waste heat to move a piston back and forth much faster than could be accomplished otherwise.

The device uses waste heat that flows through the plunger pedestal into the heat pipe and out towards the paraffin wax to cause actuation of the plunger