Grid-Sphere Electrodes for Contact With Ionospheric Plasma

Marshall Space Flight Center, Alabama

Grid-sphere electrodes have been proposed for use on the positively biased end of electrodynamic space tethers. A grid-sphere electrode is fabricated by embedding a wire mesh in a thin film from which a spherical balloon is formed. The grid-sphere electrode would be deployed from compact stowage by inflating the balloon in space. The thin-film material used to inflate the balloon is formulated to vaporize when exposed to the space environment. This would leave the bare metallic spherical grid electrode attached to the tether, which would present a small cross-sectional area (essentially, the geometric wire shadow area only) to incident neutral atoms and molecules. Most of the neutral particles, which produce dynamic drag when they impact a surface, would pass unimpeded through the open grid spaces. However, partly as a result of buildup of a space charge inside the grid-sphere, and partially, the result of magnetic-field effects, the electrode would act almost like a solid surface with respect to the flux of electrons. The net result would be that grid-sphere electrodes would introduce minimal aerodynamic drag, yet have effective electrical-contact surface areas large enough to collect multiampere currents from the ionospheric plasma that are needed for operation of electrodynamic tethers. The vaporizable-balloon concept could also be applied to the deployment of large radio antennas in outer space.

This work was done by Nobie H. Stone and Garrett D. Poe of SRS Technologies for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32567-1.

Enabling IP Header Compression in COTS Routers via Frame Relay on a Simplex Link

This algorithm allows commercial off-the-shelf routers to enter IP header compression mode without the need for a bidirectional handshake.

NASA's Jet Propulsion Laboratory, Pasadena, California

NASA is moving toward a network-centric communications architecture and, in particular, is building toward use of Internet Protocol (IP) in space. The use of IP is motivated by its ubiquitous application in many communications networks and in available commercial off-the-shelf (COTS) technology. The Constellation Program intends to fit two or more voice (over IP) channels on both the forward link to, and the return link from, the Orion Crew Exploration Vehicle (CEV) during all mission phases. Efficient bandwidth utilization of the links is key for voice applications.

In Voice over IP (VoIP), the IP packets are limited to small sizes to keep voice latency at a minimum. The common voice codec used in VoIP is G.729. This new algorithm produces voice audio at 8 kbps and in packets of 10-milliseconds duration.

Constellation has designed the VoIP communications stack to use the combination of IP/UDP/RTP protocols where IP carries a 20-byte header, UDP (User Datagram Protocol) carries an 8-byte header, and RTP (Real Time Transport Protocol) carries a 12-byte header. The protocol headers total 40 bytes and are equal in length to a 40-byte G.729 payload, doubling the VoIP latency. Since much of the IP/UDP/RTP header information does not change from IP packet to IP packet, IP/UDP/RTP header compression can avoid transmission of much redundant data as well as reduce VoIP latency. The benefits of IP header compression are more pronounced at low data rate links such as the forward and return links during CEV launch.

IP/UDP/RTP header compression codecs are well supported by many COTS routers. A common interface to the COTS routers is through frame relay. However, enabling IP header compression over frame relay, according to industry standard (Frame Relay IP Header Compression Agreement FRF.20), requires a duplex link and negotiations between the compressor router and the decompressor router. In Constellation, each forward to and return link from the CEV in space is treated independently as a simplex link. Without negotiation, the COTS routers are prevented from entering into the IP header compression mode, and no IP header compression would be performed.

An algorithm is proposed to enable IP header compression in COTS routers on a simplex link with no negotiation or with a one-way messaging. In doing so, COTS routers can enter IP header compression mode without the need to handshake through a bidirectional link as required by FRF.20. This technique would spoof the routers locally and thereby allow the routers to enter into IP header compression mode without having the negotiations between routers actually occur. The spoofing function is conducted by a frame relay adapter (also COTS) with the capability to generate control messages according to the FRF.20 descriptions. Therefore, "negotiation" is actually performed between the FRF.20 adapter and the connecting COTS router locally and never occurs over the space link. Through understanding of the handshaking protocol described by FRF.20, the necessary FRF.20 negotiations messages can be generated to control the connecting router, not only to turn on IP header compression but also to adjust the compression parameters. The FRF.20 negotiation (or control) message is composed in the FRF.20 adapter by interpreting the incoming router request message. Many of the fields are simply transcribed from request to response while the control field indicating response and type are modified.

This work was done by Sam P. Nguyen, Jackson Pang, Loren P. Clare, and Michael K. Cheng of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). **NPO-47052**

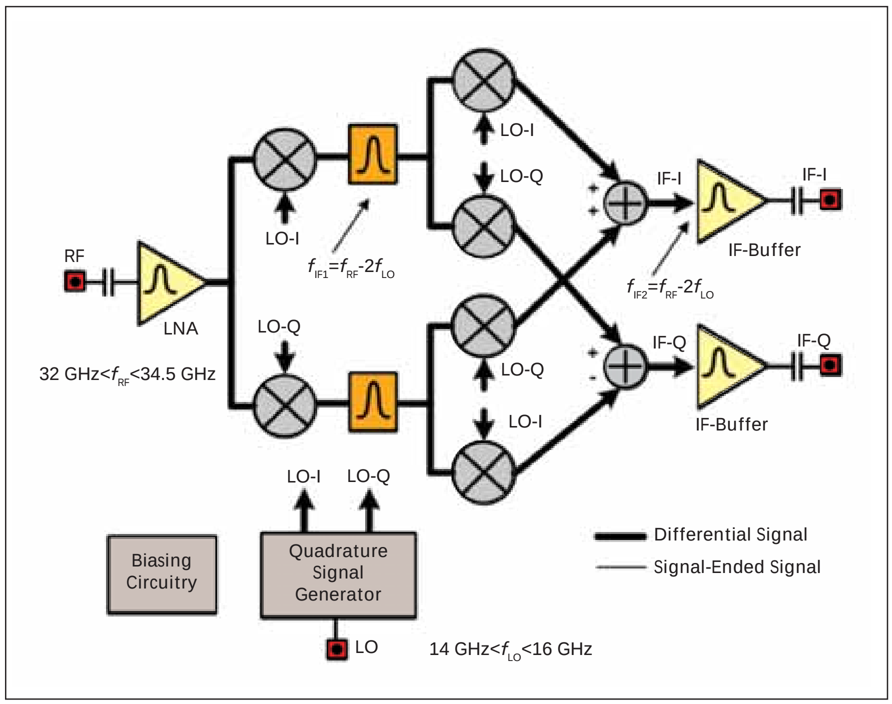
Ka-Band SiGe Receiver Front-End MMIC for Transponder Applications

New architecture improves the quality of the down-converted IF quadrature signals.

NASA's Jet Propulsion Laboratory, Pasadena, California

A fully integrated, front-end Ka-band monolithic microwave integrated circuit (MMIC) was developed that houses an LNA (low noise amplifier) stage, a down-conversion stage, and output buffer amplifiers. The MMIC design employs a two-step quadrature down-conversion architecture, illustrated in the figure, which results in improved quality of the down-converted IF quadrature signals. This is due to the improved sensitivity of this architecture to amplitude and phase mismatches in the quadrature down-conversion process. Current sharing results in reduced power consumption, while 3D-coupled inductors reduce the chip area. Improved noise figure is expected over previous SiGe-based, front-end designs.

This is the first SiGe-based receiver front-end that is capable of finding use in multiple transponder instrument programs. The design uses the latest IBM8HP SiGe process, thereby allowing for improved MMIC performance in the mm-wave regime. Improved performance is expected in terms of power consumption, quality of down-converted signals, and receiver noise figure over SiGe-based designs published by the Air Force Research Laboratory (AFRL) and the Army Research Lab (ARL).



Ka-Band SiGe-Based Receiver front-end MMIC architecture.

This work was done by Jaikrishna Venkatesan and Narayan R. Mysoor of Caltech and Hossein Hashemi and Firooz Aflatouni of the University of Southern California for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). **NPO-42708**

Robust Optimization Design Algorithm for High-Frequency TWTs

A TWT amplifier design algorithm has applications in remote sensing, biomedical imaging, and detection of explosives and toxic biochemical agents.

John H. Glenn Research Center, Cleveland, Ohio

Traveling-wave tubes (TWTs), such as the Ka-band (26-GHz) model recently developed for the Lunar Reconnaissance Orbiter, are essential as communication amplifiers in spacecraft for virtually all near- and deep-space missions. This innovation is a computational design algorithm that, for the first time, optimizes the efficiency and output power of a TWT while taking into account the effects of dimensional tolerance variations.

Because they are primary power consumers and power generation is very expensive in space, much effort has been exerted over the last 30 years to increase the power efficiency of TWTs. However, at frequencies higher than about 60