Pattern Generator for Bench Test of Digital Boards

Fresh data is streamed continuously for many tens of seconds with no gaps at 40 MHz.

NASA's Jet Propulsion Laboratory, Pasadena, California

All efforts to develop electronic equipment reach a stage where they need a board test station for each board. The SMAP digital system consists of three board types that interact with each other using interfaces with critical timing. Each board needs to be tested individually before combining into the integrated digital electronics system. Each board needs critical timing signals from the others to be able to operate. A bench test system was developed to support test of each board. The test system produces all the outputs of the control and timing unit, and is delivered much earlier than the timing unit.

Timing signals are treated as data. A large file is generated containing the state of every timing signal at any instant. This file is streamed out to an IO card, which is wired directly to the device-under-test (DUT) input pins. This provides a flexible test environment that can be adapted to any of the boards required to test in a standalone configuration. The problem of generating the critical timing signals is then transferred from a hardware problem to a software problem where it is more easily dealt with.

The first board to be tested was the ADC Digital Processor board (ADP). The ADP needed a complex Xilinx configuration data stream to operate, plus timing signals. The IO card is wired directly to the configuration and timing inputs of the board through VME connectors. A slower pattern maker program combines the Xilinx configuration and desired timing into a large data file. This data file is clocked out at 40 MHz (32 bits of data) into 28 inputs of the ADP to make it run.

The formatter board needs data from an ADP, plus timing information from the control and timing unit. Data captured from the ADP in its standalone test is combined with timing information into a large file. The large file streams out the IO card and is wired to formatter inputs. Since the formatter has more inputs than the IO card has bits, several signals were cross-strapped (duplicated), making it appear to the formatter that it was receiving two ADP boards when it was in fact receiving two copies of the same ADP board. In combined ADP/formatter integration, the IO card emulates the timing unit only.

Using IO cards to emulate missing hardware for bench test is an older technology. The improvement here is the ability to stream out fresh data continuously for many tens of seconds with no gaps at 40 MHz. This allows precise control over timing with time tag information that varies over a wide range. This allows a much better bench test than would have been possible in short pulses.

By allowing more complete testing of the individual boards when they are ready rather than deferring test to integration, the delivery of the SMAP digital system is accelerated.

This work was done by Andrew C. Berkun and Anhua J. Chu of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-48231.

670-GHz Down- and Up-Converting HEMT-Based Mixers

Applications include passive, active, or radar imaging.

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A large category of scientific investigation takes advantage of the interactions of signals in the frequency range from 300 to 1,000 GHz and higher. This includes astronomy and atmospheric science, where spectral observations in this frequency range give information about molecular abundances, pressures, and temperatures of small-sized molecules such as water. Additionally, there is a minimum in the atmospheric absorption at around 670 GHz that makes this frequency useful for terrestrial imaging, radar, and possibly communications purposes. This is because 670 GHz is a good compromise for imaging and radar applications between spatial resolution (for a given antenna size) that favors higher frequencies, and atmospheric losses that favor lower frequencies. A similar trade-off applies to communications link budgets: higher frequencies allow smaller antennas, but incur a higher loss.

All of these applications usually require converting the RF (radio frequency) signal at 670 GHz to a lower IF (intermediate frequency) for processing. Further, transmitting for communication and radar generally requires up-conversion from IF to the RF. The current state-of-the-art device for performing the frequency conversion is based on Schottky diode mixers for both up and down conversion in this frequency range for room-temperature operation. Devices that can operate at room temperature are generally required for terrestrial, military, and planetary applications that cannot tolerate the mass, bulk, and power consumption of cryogenic cooling.

The technology has recently advanced to the point that amplifiers in the region up to nearly 1,000 GHz are feasible. Almost all of these have been based on indium phosphide pseudomorphic high-electron mobility transis-