

Several key solutions are addressed in this work to solve the fabrication issues. The source/drain contact is developed using droplets of silver ink printed on the source/drain areas prior to applying CNT thin-film. The wet silver ink droplets allow the silver to “wet” the CNT thin-film area and enable good contact with the source and drain contact after annealing. A passivation layer to protect the device channel is developed by bonding a thin Kapton film on top of the device channel. This film is also used as the media for transferring the aligned CNT thin-film on the device substrate.

A simple and cost-effective technique to form multilayer metal interconnections on flexible substrate is developed and demonstrated. Contact vias are formed on the second substrate prior to bonding on the first substrate. Inkjet printing is used to fill the silver ink into the via structure. The printed silver ink penetrates through the vias to contact with the contact pads on the bottom layer. It is then annealed to form a good connection. One-dimensional and two-dimensional PAAs were fabricated and characterized. In these circuits, multilayer metal

interconnects were used to make a complete PAA system.

This work was done by Harish Subbaraman of Omega Optics, Inc., Ray T. Chen of the University of Texas at Austin, Xuejun Lu of University of Massachusetts – Lowell, and Maggie Yihong Chen of Texas State University for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-19035-1.

Battery Charge Equalizer with Transformer Array

Lyndon B. Johnson Space Center, Houston, Texas

High-power batteries generally consist of a series connection of many cells or cell banks. In order to maintain high performance over battery life, it is desirable to keep the state of charge of all the cell banks equal. A method provides individual charging for battery cells in a large, high-voltage battery array with a minimum number of transformers while maintaining reasonable efficiency. This is designed to augment a simple high-current charger that supplies the main charge energy.

The innovation will form part of a larger battery charge system. It consists of a transformer array connected to the

battery array through rectification and filtering circuits. The transformer array is connected to a drive circuit and a timing and control circuit that allow individual battery cells or cell banks to be charged. The timing circuit and control circuit connect to a charge controller that uses battery instrumentation to determine which battery bank to charge. It is important to note that the innovation can charge an individual cell bank at the same time that the main battery charger is charging the high-voltage battery.

The fact that the battery cell banks are at a non-zero voltage, and that they are

all at similar voltages, can be used to allow charging of individual cell banks. A set of transformers can be connected with secondary windings in series to make weighted sums of the voltages on the primaries.

This work was done by Francis Davies of Johnson Space Center. 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, Johnson Space Center, (281) 483-1003. Refer to MSC-25026-1.

An Efficient, Highly Flexible Multi-Channel Digital Downconverter Architecture

This technology can be used for any digital recording device that requires a flexible way to break a large input bandwidth into many smaller channels.

NASA's Jet Propulsion Laboratory, Pasadena, California

In this innovation, a digital downconverter has been created that produces a large (16 or greater) number of output channels of smaller bandwidths. Additionally, this design has the flexibility to tune each channel independently to anywhere in the input bandwidth to cover a wide range of output bandwidths (from 32 MHz down to 1 kHz). Both the flexibility in channel frequency selection and the more than four orders of magnitude range in output bandwidths (decimation rates from

32 to 640,000) presented significant challenges to be solved.

The solution involved breaking the digital downconversion process into a two-stage process. The first stage is a 2× oversampled filter bank that divides the whole input bandwidth as a real input signal into seven overlapping, contiguous channels represented with complex samples. Using the symmetry of the sine and cosine functions in a similar way to that of an FFT (fast Fourier transform), this downconver-

sion is very efficient and gives seven channels fixed in frequency. An arbitrary number of smaller bandwidth channels can be formed from second-stage downconverters placed after the first stage of downconversion.

Because of the overlapping of the first stage, there is no gap in coverage of the entire input bandwidth. The input to any of the second-stage downconverting channels has a multiplexer that chooses one of the seven wideband channels from the first stage. These second-stage

downconverters take up fewer resources because they operate at lower bandwidths than doing the entire downconversion process from the input bandwidth for each independent channel. These second-stage downconverters are each independent with fine frequency control tuning, providing extreme flexibility in positioning the center frequency of a downconverted channel. Finally, these second-stage downconverters have flexible decimation factors over four orders of magnitude.

The algorithm was developed to run in an FPGA (field programmable gate array) at input data sampling rates of up to 1,280 MHz. The current implementation takes a 1,280-MHz real input, and first breaks it up into seven 160-MHz complex channels, each spaced 80 MHz apart. The eighth channel at baseband was not required for this implementation, and led to more optimization. Afterwards, 16 second stage narrow band channels with independently tunable center frequencies and bandwidth settings are implemented.

A future implementation in a larger Xilinx FPGA will hold up to 32 independent second-stage channels.

This work was done by Charles E. Goodhart, Melissa A. Soriano, Robert Navarro, Joseph T. Trinh, and Elliott H. Sigman 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 Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-47431.

Dimmable Electronic Ballast for a Gas Discharge Lamp

Lyndon B. Johnson Space Center, Houston, Texas

Titanium dioxide (TiO₂) is the most efficient photocatalyst for organic oxidative degradation. TiO₂ is effective not only in aqueous solution, but also in non-aqueous solvents and in the gas phase. It is photostable, biologically and chemically inert, and non-toxic. Low-energy UV light (approximately 375 nm, UV-A) can be used to photoactivate TiO₂. TiO₂ photocatalysis has been used to mineralize most types of organic compounds. Also, TiO₂ photocatalysis has been effectively used in sterilization. This effectiveness has been demonstrated by its aggressive destruction of microorganisms, and aggressive oxidation effects of toxins. It also has been used for the oxidation of carbon monoxide to carbon dioxide, and ammonia to nitrogen.

Despite having many attractive features, advanced photocatalytic oxidation processes have not been effectively used for air cleaning. One of the limitations of the traditional photocatalytic systems is the ballast that powers (lights) the bulbs. Almost all commercial off-the-shelf (COTS) ballasts are not dimmable and do not contain safety features. COTS ballasts light the UV lamp as bright as the bulb can be lit, and this results in shorter bulb lifetime and maximal power consumption. COTS magnetic ballasts are bulky, heavy, and inefficient.

Several iterations of dimmable electronic ballasts have been developed. Some manifestations have safety features such as broken-bulb or over-tempera-

ture warnings, replace-bulb alert, log-bulb operational hours, etc.

Several electronic ballast boards capable of independently lighting and controlling (dimming) four fluorescent (UV light) bulbs were designed, fabricated, and tested. Because of the variation in the market bulb parameters, the ballast boards were designed with a very broad range output. The ballast boards can measure and control the current (power) for each channel.

This work was done by Marius Raducanu and Brian D. Hennings of Lynntech, Inc. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24333-1