Hilco Streambank

A Hilco Global Company
Vested in Your Success

OFFERING - APRIL 2015

Acquisition Opportunity:

Portfolio of IP including Patents, Patent Applications, and SBIR Rights.

AURIGA MICROWAVE

INTRODUCTION

Hilco Streambank has been retained as the exclusive agent for purposes of marketing and selling the intellectual property portfolio (the "Assets") of Auriga Measurement Systems, LLC (the "Company"). The Company recently ceased operations and is in the process of selling off its assets.

The Assets include patents, patent applications, SBIR rights, considerable technical design, testing and measurement data, prototype devices, and proof of concept models.

These Assets relate to technology in Radio Frequency (RF) power amplifiers (PA), LNA (Low Noise Amplifiers), high-power switches, and several other categories, described below. Upon execution of a confidentiality agreement interested parties will be admitted to an online data room to view further diligence information.

BACKGROUND

Founded in 2004, Auriga Measurement Systems, LLC (dba Auriga Microwave for the past several years) was formed by uniting Agilent Technologies' east coast Component Test Systems group, ATN's device and component measurements systems organization and ACCO USA's device and component modeling and characterization teams. By acquiring the IP and exclusive licensing from these companies, and combining its operations, the newly formed Auriga team built on solid customer relationships and referral business to successfully launch the Company with a seamless test, measurement, characterization and design business in the very challenging RF space specializing in gallium nitride (GaN) and gallium arsenide (GaAs) technologies.

Auriga's founders have been engaged in solving the most complex and challenging design, modeling, measurement, and device characterization problems in the RF microwave market, becoming a leader in optimizing GaN and GaAs designs across a broad frequency spectrum of, typically, high-power RF applications.

Some of the Auriga teams' influential industry contributions include:

- First solid-state electronic tuner for noise parameter and power load-pull measurements
- First to develop on-wafer precision noise parameter and load-pull measurements
- First to offer full DC and RF pulsed modeling and characterization services on customer devices
- Tajima-Hsu Model - widely adopted GaAs device model for the compound semiconductor GaAs industry developed by Auriga's CTO, Yusuke Tajima
- First in providing fully-automated solid-state and mechanical hybrid load-pull and noise parameter test systems for both on-wafer and package devices
- One of the first test system integration houses to design, develop and ship Synthetic Instruments-based manufacturing test systems for T/R module tests, covering 1-50 GHz, CW and pulsed measurement capability
- More than 20 patent-pending or patents created by Auriga personnel

Auriga worked with the industry's most sophisticated technology in designing high-powered RF and microwave devices. The Company designed, manufactured, and delivered, balanced solutions. Prime contractors and the DoD, in particular, turned to Auriga when multiple, concurrent challenging technical requirements needed to be met, e.g., when efficiency, bandwidth, linearity and size all need to be optimized. As evidence to this, Auriga was awarded eleven (11) SBIR Phase I's and seven (7) Phase II's (and beyond), and received over $8M in government funding over the last 6 years. SBIR stands for Small Business Innovative Research, with the emphasis being on innovative, leading-edge technology.

In addition the company received approx. $4 million in R&D type contracts from the private sector.

The Company has accumulated a portfolio of 20 issued or pending patents.

OPPORTUNITY

Currently the Company is selling its IP portfolio.

The following descriptions relate to five (5) different highlighted solutions:

- **Red Sox** - high data rate signals by maintaining very high efficiency over a wide dynamic range with a large instantaneous bandwidth at high power.
- **Auriga SMART™** - a component-based, adaptive technology, which provides peak power, maximum efficiency, and improved linearity.
- Revolutions / Linearity - linearity enhancement technology.
- **LNAs (Low-Noise Amplifiers)** - LNA monolithic microwave integrated circuits (MMICs) and modules capable of operating over a wide range of temperatures, including cryogenic.
- **Envelope tracking (ET)** - RF PA design in which the power supply voltage applied to the PA is continuously adjusted to ensure that the PA is operating at peak efficiency at each instant of transmission.

Each description outlines the respective technology, its features and benefits, and provides a listing of the assets related to the described technology.

In addition to these five (5) highlighted solutions the Company had also developed other technologies which are described in the **'Additional Technology'** section following the below descriptions. These additional technologies include **other patents** and **additional SBIR rights**.

Red Sox (code name)

Description

Red Sox supports high data rate signals by maintaining very high efficiency over a wide dynamic range with a large instantaneous bandwidth at high power. Recent progress in CMOS technology gives rise to new possibilities in microwave system architectures for telecommunications. The Company's Red Sox technology for next-generation commercial and military RF transmitters utilizes that soon-to-be available CMOS technology. All front-end functionality, from digital signal input to RF output, is addressed by Red Sox algorithms. The principal target market is commercial infrastructure and high-power military communication platforms where high efficiency over a wide dynamic range is critical.

Features/Benefits

Red Sox algorithms exploit software-controllable digital circuitry, which is fast, inexpensive, and often already present in existing wireless hardware. Ultimately, the transmitter will consist of one CMOS and one RF MMIC, probably assembled into a single, compact package, for lower output power applications. Red Sox is simpler; it eliminates the chain of

LOs and up-conversion stages, further reducing size, weight and cost.

Competing technologies' performance, like envelope-tracking and Doherty amplifiers, is limited by analog circuitry. Providers using these methods are forced to increase size and compromise efficiency to meet the multi-band and multi-channel demands of 4G and 5G. There is doubt that these competitive, analog-based solutions can keep-up with next-generation demands.

By moving functionality that is traditionally handled by analog or RF circuitry to the digital domain, performance is improved, cost is lowered, size is reduced, there is better support for future needs, and hardware integration is simplified. Auriga's output-stage demonstrated more than 60% drain efficiency over a 9 dB dynamic range. The Red Sox approach supports all known commercial and military waveforms with unprecedented efficiency. Early-stage proof-of-concept (POC) measurements have validated our simulations. A plan to develop two prototypes over a short 14 month period went unfunded due to management changes at an interested strategic partner.

Related Assets

- Five (5) provisional patents**
- Four (4) patent applications**
    - 14/604,287
    - 14/308,058
    - 14/307,971
    - 14/308,034
- Two (2) of the nine (9) patents require significant advances in FPGA speed and in RF bandwidth, which may make them not applicable for several years
- Simulations, schematics, designs, a bench design, etc.

** All but one (1) of the above mentioned five (5) provisional patents and four (4) patent applications are implemented within an FPGA

Auriga SMART™

Description

SMART™ = Sensing, Managing, Adapting Receiver/Transmitter

Auriga SMART™ is targeted at DoD applications. To achieve optimal multi-function performance, a system should utilize adaptive, rather than fixed-function components. Auriga SMART™, a component-based, adaptive technology, provides peak power, maximum efficiency, improved linearity, etc. when needed, to enhance system performance. Additionally, multiple performance needs, e.g., peak efficiency and linearity, may be met simultaneously with SMART. There are no frequency or bandwidth limiting elements required by the approach, so all radar, EW and communications missions can be simultaneously supported. By replacing multiple focused systems with a single adaptive one, all elements of SWAP-C (Size, Weight, Power and Cost) can be satisfied.

The military is faced with two seemingly conflicting objectives for current and next-generation systems, i.e., increase performance and reduce cost. Deploying multiple single-function systems, e.g., radar, electronic warfare (EW) or communications, on military platforms has proven to be too costly, bulky and performance limiting. Consequently, some functions are not available on all platforms, which create significant limitations. A UAS, for example, flying with radar, but without jamming can "see" targets but has no means of protecting itself. Warfighters carry communication devices that support a diverse set of waveforms, but trade-off talk time. Placing radars, jammers, and communication systems in close proximity to conserve space often limits simultaneous operation. All of these issues must be resolved in order to keep pace with the SWAP-C requirements of military platforms.

Features/Benefits

There are no frequency or bandwidth limiting elements required by the SMART approach so all radar, EW, and communications missions, can be simultaneously supported. By replacing multiple focused systems with a single adaptive one (adaptive at the component level) it satisfies all elements of SWAP-C.

Another approach to solve the conflicting objectives mentioned above is to combine multiple single-function systems into one software-controlled, multi-function system that would solve the above-mentioned problems. This "one system fits all" approach would decrease development cost (fewer systems to design), decrease deployment costs (less different hardware to build and ship), and decrease support costs (less fuel and reduced SKUs to support and spare), but would be expensive and take lots of space, where none exists.

Conventional systems are specifically designed to do one thing well. Competing adaptive solutions suffer from high loss (i.e., typically 3-10 dB), but SMART consumes only tenths of a dB loss (practically lossless). There are no power or bandwidth limitations in the approach and any platform that supports solid-state technology can also support SMART. Adaptability is implemented using fast-switch technology, so reaction times are measured in nanoseconds, as opposed to microseconds or more.

Related Assets

- Two (2) patent applications
  - 14/543,767
  - 14/543,371
- Simulations, schematics, designs, etc.

Revolutions (code name) / Linearity

Description

Revolutions is a code name for Auriga's linearity enhancement technology. Linearization is realized by creating two signal paths, linear and non-linear. An amplifier stage is incorporated in the non-linear path and the signal from the linear path is combined with the signal from the non-linear path. Revolutions uses analog pre-distortion (APD) to modify the incoming signal to cancel the distortion added by power amplifier (PA). The PA and linearization circuits are integrated and packaged, requiring no other interface or digital chips to accomplish required linearity goals.

Features/Benefits

PAs utilizing APD are self-contained and do not require any interface other than the RF input signal and bias supply. Other linearization techniques, such as digital pre-distortion (DPD), require a digital waveform interface which is not readily available in many systems. Linearity of existing PAs can be improved in a small package by placing the linearizer prior to the PA to "condition" the input signal. The Linearizer can be integrated as a part of the PA.

Related Assets

- Two (2) patent applications
  - 13/788,824
  - 13/788,407
- SBIR Phase II Data Rights
- Simulations, schematics, designs, etc.

Low-Noise Amplifiers (LNAs)

Description

The objective for SBIR N07-194 Phase 2.5 was that Auriga would fabricate and test LNA monolithic microwave integrated circuits (MMICs) and modules capable of operating over a wide range of temperatures, including cryogenic. LNAs at cryogenic temperature are expected to have significantly reduced noise performance (by more than 4x). The frequency range of interest is 0.002-8 GHz. Suitable LNAs are available off-the-shelf for the 0.002-0.5 GHz band. Auriga was responsible for designing octave LNAs to cover 0.5-8 GHz.

Auriga was tasked with completing the following objectives:

- Extract a noise model of GaN transistors across temperature (including cryogenic)
- Design and build four octave LNAs capable of cold-temperature operation
- Characterize LNA performance across temperature

The initial goals of SBIR N07-194 were to develop a prototype of a mast-mounted, shipboard LNA module that has state-of-the-art electrical performance and can withstand severe weather and corrosive environments. Through Phase II and Phase 2.5, Auriga's GaN LNA technology provided unparalleled input power handling and IP3 while minimizing noise figure. Four bands were covered, i.e., 0.5-1.0 GHz, 1-2 GHz, 2-4 GHz, 4-8 GHz, with challenging goal across a large range of temperatures. Funding to finish the project, along with conversations with several potential acquirers of this technology, were ongoing when Auriga ceased business operations.

Features/Benefits

Unparalleled input power handling with minimal power consumption is critical for phased array radar applications

Related Assets
- SBIR Phase II Data Rights
- Simulations, schematics, designs, etc.

Envelope Tracking (ET)

Description

Envelope tracking describes an approach to RF PA design in which the power supply voltage applied to the PA is continuously adjusted to ensure that the PA is operating at peak efficiency at each instant of transmission. As the crest factor of the signal increases, which is becoming more and more common, a PA in a constant supply voltage environment will operate below its maximum efficiency, decreasing battery time, for example, and/or operating costs.

Related Assets
- Four (4) patents issued
    - 12/618,192
    - 13/442,355
    - 13/492,840
    - 13/767,018
- SBIR Phase I (N093-221)
- Simulations, schematics, designs, a bench design, etc.

Additional Technology (Other Patents and SBIR's)

Patents

Related Assets
- High-power Radio Frequency (RF) Switch, 13/077,096 – Issued
- Inverse Class F using Balun, 12/970,240 – Issued
- High Frequency Coaxial Balun and Transformer, 13/108,160 - Issued

SBIRs (over $8m has been spent by the US government for Auriga to develop leading-edge technology)

Related Assets (SBIR Phase II, 2.5 and III) and SBIR Data Rights
- High-power (400 W) GaN PA (N07-007), 2009-2011
- NextGen Jammer (N09-039, III), 2009-2011
- High-power RF Switch (A08-007), 2010-2012
- S-band PA (N08-172), 2010-2012
- C-band, PA & LNA (N07-007, 2.5), 2011-2012
- Linearization (Revolutions), 2012-2014
- SPAWAR LNAs (N07-194, 2.5), 2013-2014
- GDPAA (AF121-159), 2013-2014

SBIR Phase I (only)
- Linearized high-frequency (44 GHz) PA (AF083-155), 2009
- Linearity improvement (A10-015), 2010
- Low-noise Downconverter (AF103-178), 2011
- Thermal Management (N111-023), 2011
- High-power X- and Ka-band Gallium Nitride Amplifiers (NASA 01.05), 2012
- SWAP-C for GDPAA Diplexer (AF131-148), 2013
- GaN Foundry assessment (N132-095), 2013

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Sale Process

Non-Disclosure Agreement

Parties with further interest in the opportunity can execute an NDA for access to assembled diligence materials.

Diligence Period

The diligence period will be through May 15th, 2015. A virtual data room will be made available to interested parties.

Expressions of Interest

Expressions of interest should be submitted by May 15, 2015. Further instructions regarding submission of an expression of interest will be provided upon request.

For further information about the sale process and access to diligence materials please contact the following Hilco Streambank representitives:

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About Hilco Streambank
Hilco Streambank is a market leading advisory firm specializing in intellectual property disposition and valuation. Over the last three years Hilco Streambank has become a leader in the IP valuation and disposition market. Having completed numerous transactions including sales in publicly reported Chapter 11 bankruptcy cases as well as private transactions, Hilco Streambank has established itself in the internet and telecom community as a responsible and effective intermediary in the space.