NAVSEA
WARFARE CENTERS
CRANE

CRANE DIVISION

NAVAL SURFACE WARFARE CENTER

NAVSEA
WARFARE CENTERS
CRANE

“Dual Channel Downconverter for Pulsed Radio Frequency Measurements”

Presented by
K. Bryan Mitsdarffer

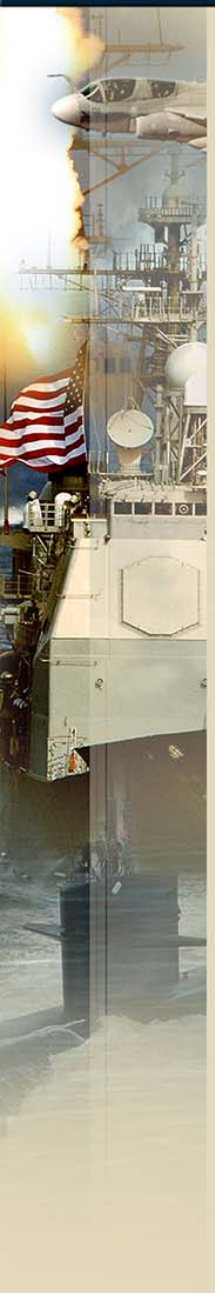
K. Mitsdarffer, L. Hoover, D. Thelen;

US Patent #7,058,377

Technology Description

- **What is it:**
  - **The DCR (aka Dual Channel Receiver) is a patented cost effective way of converting RF (radio frequency) & MW (microwave) signals easily into to a lower frequency to be able measure critical performance parameters of devices like…**
- **Current and Future Applications/Devices:**
  - **Commercial:**
    - **Telecommunications components**
    - **(cell phones, transmitters/receivers, high power amplifiers, etc)**
  - **Medical:**
    - **R&D, Test and support of Medical RF/MW radiation sources, for Imaging or treatment applications**
  - **Specialized:**
    - **Custom applications can be made**
  - **Military:**
    - **Radar and Electronic Warfare components**
    - **Satellite comm.**

Technology Description



- **How is it made:**
  - **By taking a reference signal and a device's under test's output signal, they are down converted into measureable signals for analysis.**
- **Problem/Need:**
  - **The US Navy must accurately measure radar and EW transmitter components in-system.**
- **Major Challenges:**
  - **Transmitters use complex waveforms**
    - **Frequency agility**
    - **Modulations (FM, phase coding, multiple PRFs)**
  - **Must be highly adaptable**
    - **Changing test requirements**
    - **Support for radar, EW, and communication systems**
    - **Use COTS plug-in digitizers for sustainment**

Technology Description

- **What makes it special:**
  - **There is no other single commercial instrument that is capable of fully characterizing RF and MW components in-system.**
- **Why did you make it:**
  - **U.S. Navy radar and EW systems incorporate the most advanced transmitter components in the world. It is often necessary to measure the performance of its components in-system during development, production and support.**

NSWC Crane Solution

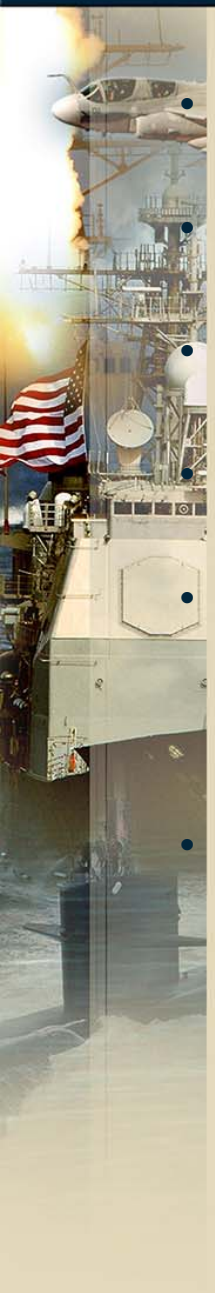
Transmitter Component Analyzer (TCA)

- **Automatic RF measurements performed in-system**
  - **Insertion gain and phase**
  - **RF power spectrum**
  - **Demodulated I and Q**
  - **Clutter improvement factor**
  - **Phase noise and AM noise**
  - **RF pulse jitter and pulse-to-pulse stability**

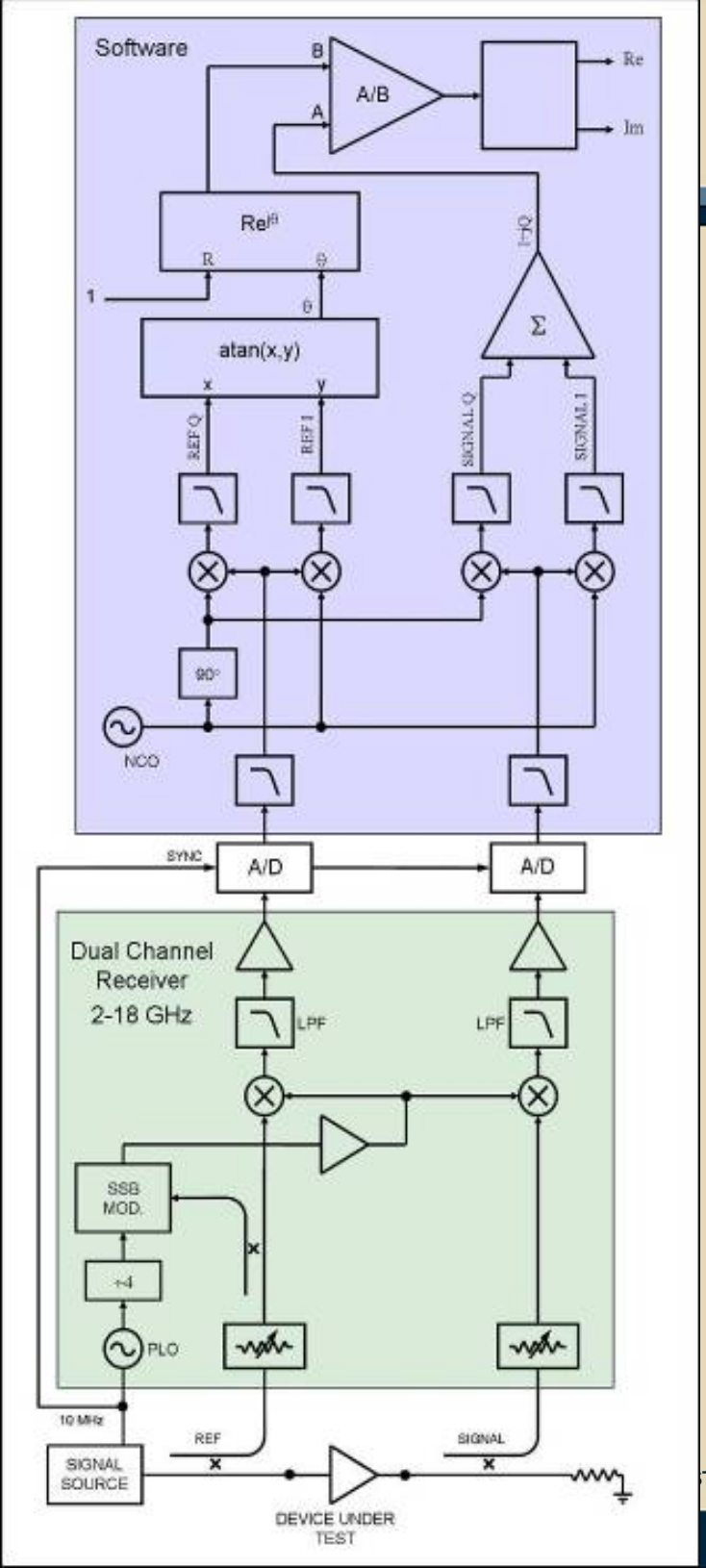
Technology Description

- **Where is it found currently:**
  - **It is used in a variety of test applications for support of the Navy's Radar and EW microwave tube test systems.**
- **What are its limitations:**
  - **Limited to 2 port devices & 16 bit Acquisitions**
    - **(Currently the state of the art in the market, and upgradable)**
- **What are the main components:**
  - **Dual Down Converter, HS-Digitizer and COTS PC.**
- **What are its main capabilities:**
  - **Ability to measure a variety of spectral and time domain measurements such as:**
    - **Insertion Gain and Phase, RF Power Spectrum, Demodulated I and Q, Amplitude Noise, Phase Noise, Intra-pulse Noise, Clutter Improvement Factor as well as power spectrum, peak power and frequency, in-band power, adjacent-channel power, and occupied bandwidth, as well as 3D spectrogram capabilities. Error vector magnitude (EVM) and adjacent channel leakage ratio (ACLR).**

TCA Project Timeline



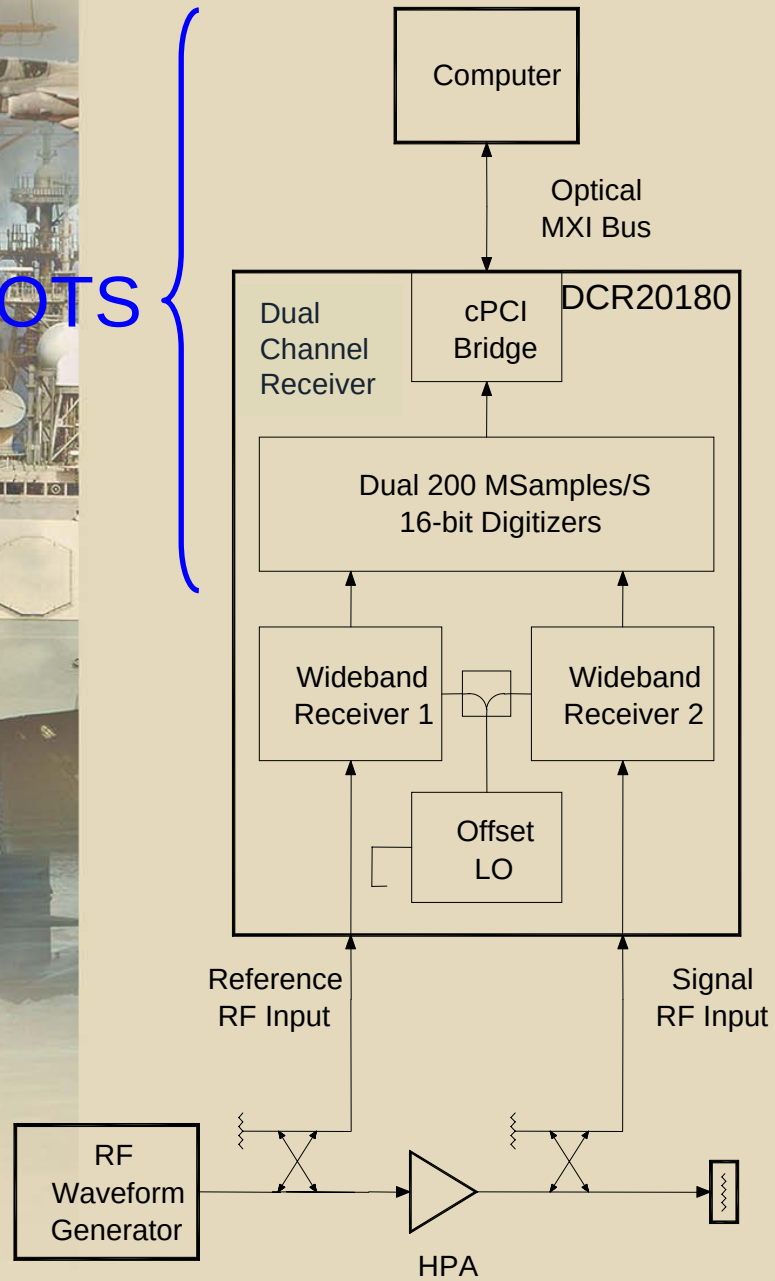
- **Initial concept** **(March 2001)**
- **Prototype demonstration** **(February 2002)**
- **First 8 systems deployed** **(December 2003)**
- **U.S. Patent #7,058,377** **(June 2006)**
- **3rd generation TCA with 2-18 GHz receiver and real-time software** **(October 2008)**
- **4th generation TCA 12 bit to 16 bit resolution increase** **(August 200)**



How does it work:

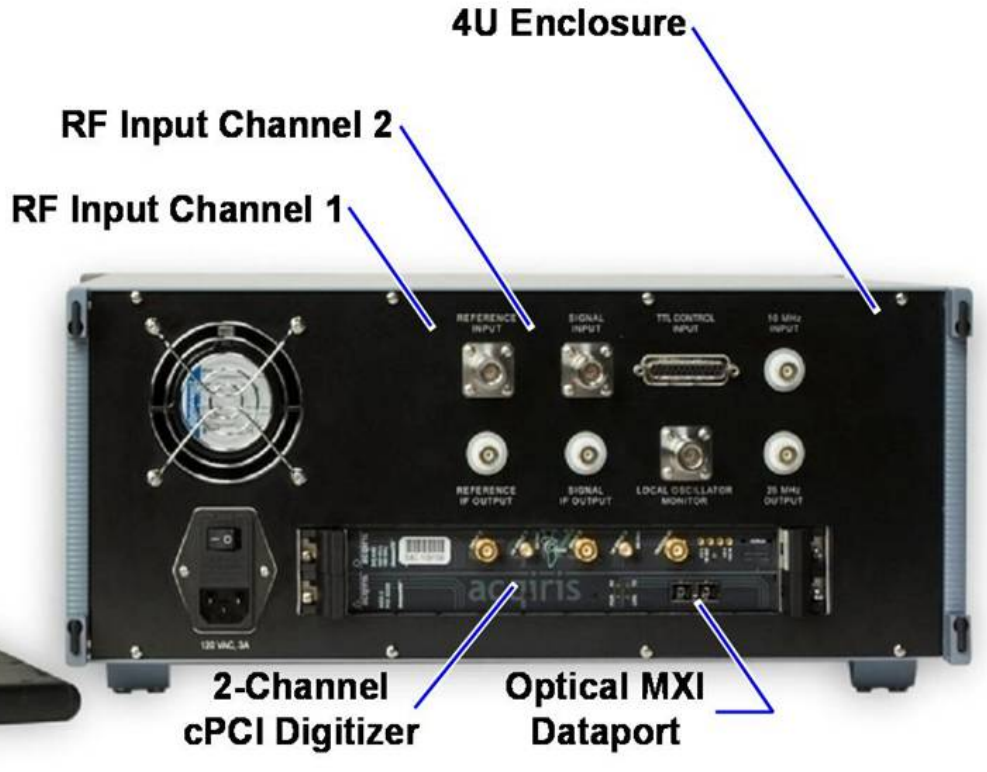
- **Acquisition: (Patented Method)**
  - **A signal and its reference are taken from a device under test, modulated and mixed down from RF (radio frequency) to HF (high frequency).**
- **A/D:**
  - **A digitizer is used to convert the HF into digital signals and read into a computer as waveforms.**
- **Software:**
  - **The software, process's the acquired waveforms to get the desired measurements. (LabVIEW 8.5)**

High Power Amplifier Test



- **TCA Specifications:**
  - **RF Frequency: 2-18 GHz**
  - **RF Power: -10 dBm to +40 dBm**
  - **Receiver Bandwidth: 100 MHz**
  - **Noise Floor: -150 dBc/Hz**
  - **Phase Accuracy: 0.2° rms**
  - **Resolution: 16 bits**
  - **Sample Rate: 200 MSamples/s**
  - **Interface: Optical MXI-3**

What does it look like?



COMMERCIAL APPLICATIONS

- **Who would use it?:**
  - **Anyone needing to make high quality, accurate and repeatable RF/MW measurements on 2 port devices. For example:**
    - Cell Phone R&D/Testing/manufacturing
    - RF Electronics R&D/Testing/Manufacturing
    - Research, Commercial, Medical and Military
- **Why would they want it?:**
  - **One device replaces the need to have a complex network of devices to make the same measurements. *(A 10 to 1 reduction in equipment, cost savings $)**
  - **Initial savings of comparable equipment:(<$100K)**
    - Sig Gen 30k, Spec An: 50k, DSA: 25k, Phase shifters(1):3k, Hybrid coupler: 10k, Mixers: 20K, LNA's: 2K, LPF: 1K,
  - **Recurring cost of Calibration and maintenance more than $5k/yr as supposed to <$100/yr calibration cost**

Commercial Applications

- **How would it be used?:**
  - **Either in conjunction with other test equipment or as a deployable “one stop box” for a multitude of measurements.**
  - **Current applications include:**

Insertion Gain and Phase, Amplitude Noise, Phase Noise, Intra-pulse Noise, Clutter Improvement Factor of certain Aegis MWT.

Commercial Applications

- **Benefits:**
  - **Higher resolution (dynamic range)**
  - **Low noise**
  - **Repeatable**
  - **Reliable and deployable**
  - **Lower initial cost**
  - **Even lower recurring cost ($10 to 1)**