Two-Way Update

Presented by

Microcom Design, Inc.

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General Two-Way History

- **Long been a desire of the DCS community to have a communication link to the remote DCPs.**
  - **The addition of Two Way communications would considerably enhance the value of the entire DCS system.**
  - **Also known as DCPI (interrogate) and DCPC (command).**
- **Original 1965 design was based on Interrogate Operation**
  - **DCPI was never widely utilized due to limited capability and cost of receivers.**
  - **DCPI link terminated around 2005 since it did not meet NTIA Power Spectral Density (PSD) requirements.**
- **Work by NOS/Sutron (circa 2007-2009) proved feasibility of a spread spectrum approach to meet PSD.**
  - **DCPC utilized Direct Sequence Spread Spectrum (DSSS).**
  - **Never fully implemented by NOAA.**
- **Transponders have always been available.**
  - **GOES-R series satellites include DCP I/C transponder, but may be removed from future satellites if not utilized.**

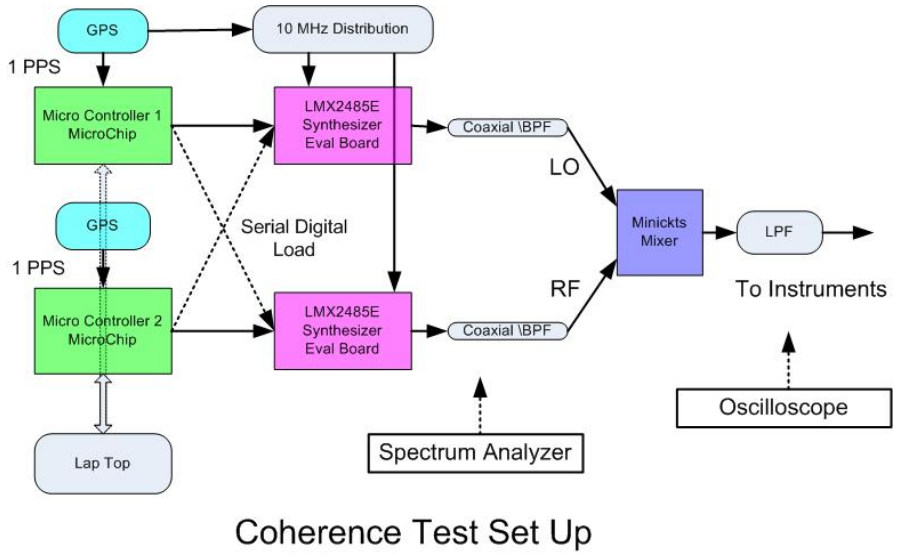
2015 Two-Way Study

- **In 2015, NOAA tasked Microcom with performing comprehensive study on resurrecting the Two-Way**
- **Two-Way Link Concerns:**
  - **DCS is an NTIA Secondary Licensee on non-Interference basis with FCC Primary Licensees**
  - **Primary Licensee is Land Mobile Radio (LMR).**
- **Study results presented at April TWG and formal report submitted to NOAA In July.**
- **2015 Study Key Recommendations:**
  - **Frequency Hopping Spread Spectrum (FHSS) instead of DSSS.**
    - **FHSS will perform better in busy LMR environment.**
  - **NOAA to fund and provide reference receiver design.**
  - **Utilize DADDS to provide secure User interface for sending commands, confirming receipt, and delivering response.**
  - **Synchronize hop pattern, packet structure and error correction (Reed-Solomon) to UTC.**
    - **Quicker acquisition when time known, allows time sync when not.**

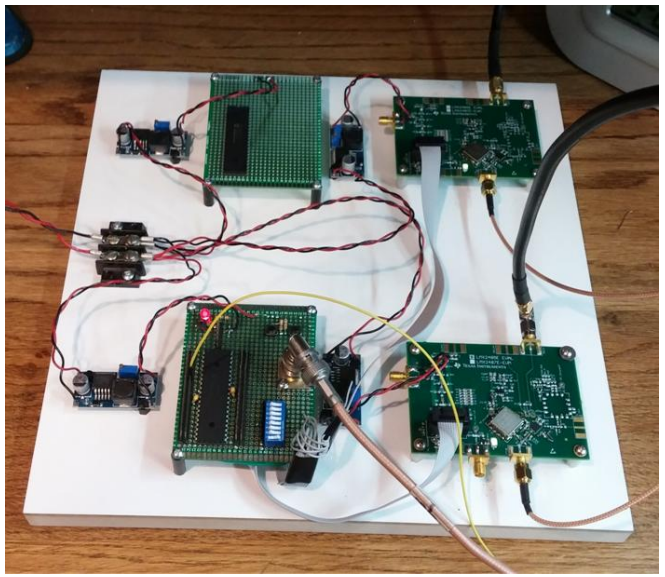
2016 Two-Way Study

- **In 2016 NOAA authorized Microcom to perform a follow-on study to further confirm the FHSS recommendation.**
- **2016 Study Goals**
  - **Extend simulation models to better confirm FHSS performance in presence of LMR interference.**
  - **Evaluate impact on Bit Error Rate (BER) with truncated RS (250,218).**
- **Study results presentation at May TWG.**
- **2016 Study Key Results**
  - **Simulations confirmed only minor BER degradation in the presence of two simulated, 20 dB stronger LMR signals.**
  - **Negligible performance difference for shortened RS (250,218) versus (255,233); shortened code showed slight improvement.**
- **Following 2016 TWG, NOAA requested proposal to build prototype modulator and demodulator for bench test.**
- **Bench prototype work began in the fall of 2016.**

Bench Prototype Update – Phase Coherence

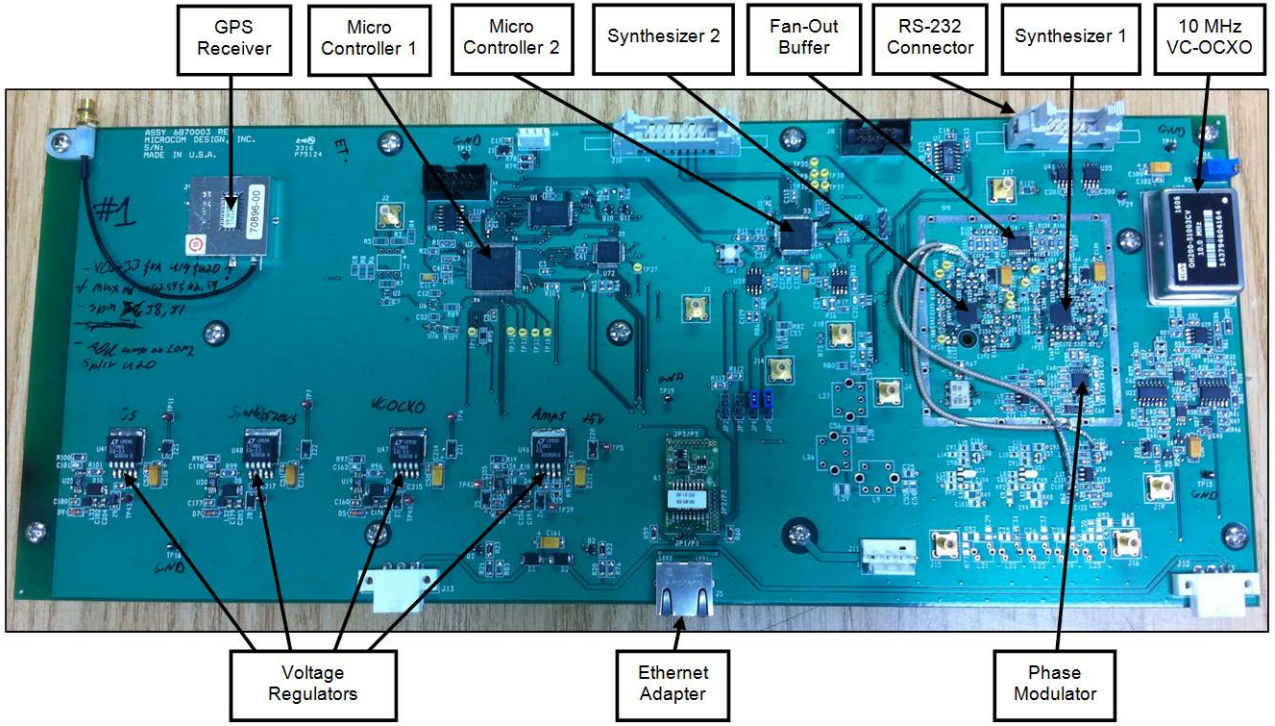


Coherence Test Set Up



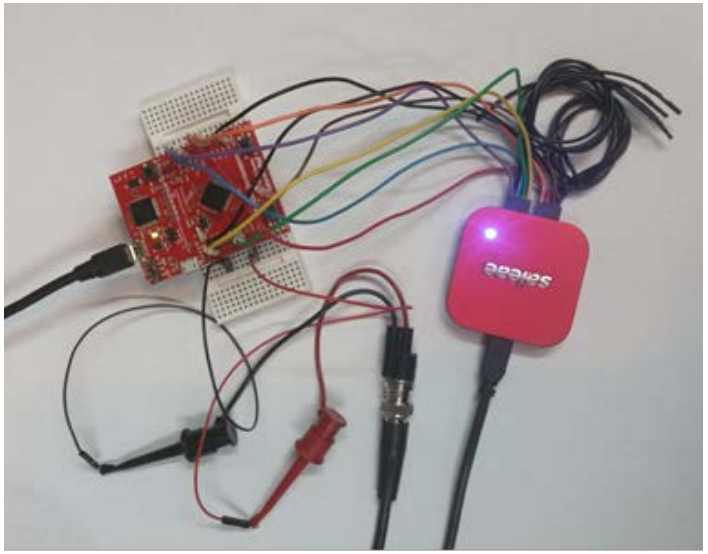
- **First step in bench prototype project was to develop a test set up to confirm synthesizers can maintain phase coherence on hops.**
- **Test setup consisted of two LMX2485E Synthesizer Evaluation boards connected to Microchip Micro Controllers interfaced to a Laptop.**
- **Synthesizers were stepped in synchronisms utilizing GPS, and phase coherence from hop-to-hop was confirmed.**

Bench Prototype Update - Modulator



- **Modulator completed in fall; custom design based on DCS Pilot/Test Transmitter previously designed for NOAA.**
- **Can produce a variety of test signals to support the demodulator development; including desired FHSS BPSK signal at 200 bps with pseudo-random data.**

Bench Prototype Update - Demodulator



- **Demodulator to be built off several evaluation boards; including ARM Cortex 4 development board shown to right (TI TM4C123).**
- **Once signal was digitally sampled, remaining signal processing handled in code.**
- **Demodulator Functions Realized:**
  - **ADC Sampling of a 455 kHz carrier with …**
  - **Direct digital down conversion to 25 kHz.**
  - **Digital generation of a 25 kHz LO.**
  - **Initial development of carrier phase lock.**
- **Task put on hold before demodulator could be completed.**

Two-Way Project Status

- **Two-Way bench prototype put on hold due to budget and priority concerns.**
- **Unexpected DCS Management change and focus on GOES-16 has delayed resuming project.**
- **NOAA has requested and recently been provided proposal to complete task for consideration.**
- **If authorized in the near future, goals will be …**
  - **To complete demodulator by end of 2017.**
  - **To begin end-to-end bench testing in early 2018.**
  - **To provide BER results with channel noise (AWGN) and simulated LMR interference by March 2018.**