

# GOES CDMA Overlay Project

A Software Radio Approach



MICROCOM DESIGN

Richard Schwarz

# Project Goals

- **Determine feasibility of CDMA Overlay**
- **Evaluate and Test Current System Hardware**
  - **Satellite filter wideband specs**
- **Implementation a Flexible Software Radio Prototype Eval System**
- **Actual in system testing**
- **Actual working prototype system**



# Description

- **CDMA Overlay Project will evaluate a CDMA/TDMA overlay system using highly flexible and programmable hardware and analysis tools using a flexible software radio approach.**
  - **Phase 1 Evaluation System: –Matlab/AMIQ/PC Digitizer**
    - **Fully digital Matlab Preprocessed test signals**
      - Rohde Schwarz AMIQ
    - **Digitization of entire IF and post processing demodulation**
      - GAGE PC Digitizer
  - **Phase 2 Evaluation System: Prototype Software Radio Approach**
    - **Modification of existing Microcom equipment**
    - **Real hardware-ready to use**



# Hardware Analysis

- **Existing System Evaluation**
  - System bandwidth, filters etc.
    - Satellite band pass filter
      - Linearity
      - Ripple
      - Spreading SNR impact
  - Existing TDMA system Stats
    - Microcom's Database analysis software



# CDMA Analysis

- **Coding Properties**
  - Chip Rate
  - Type of codes
    - Tap, Length, Fill, programmable
    - GOLD, Kassami, Maximal, Any.....
    - Number of channels
- **Noise & interfere immunity (MAI,TDM)**
- **Preamble approach**



# CDMA Simulation System

- **Phase 1: Matlab Post Digitizer Processor**
  - **MATLAB Test Signal Generation**
  - **Rohde Schwarz AMIQ Tx Digital to Analog**
  - **GAGE Digitizer card Rx Analog to Digital**
  - **MATLAB Down conversion and Analysis**

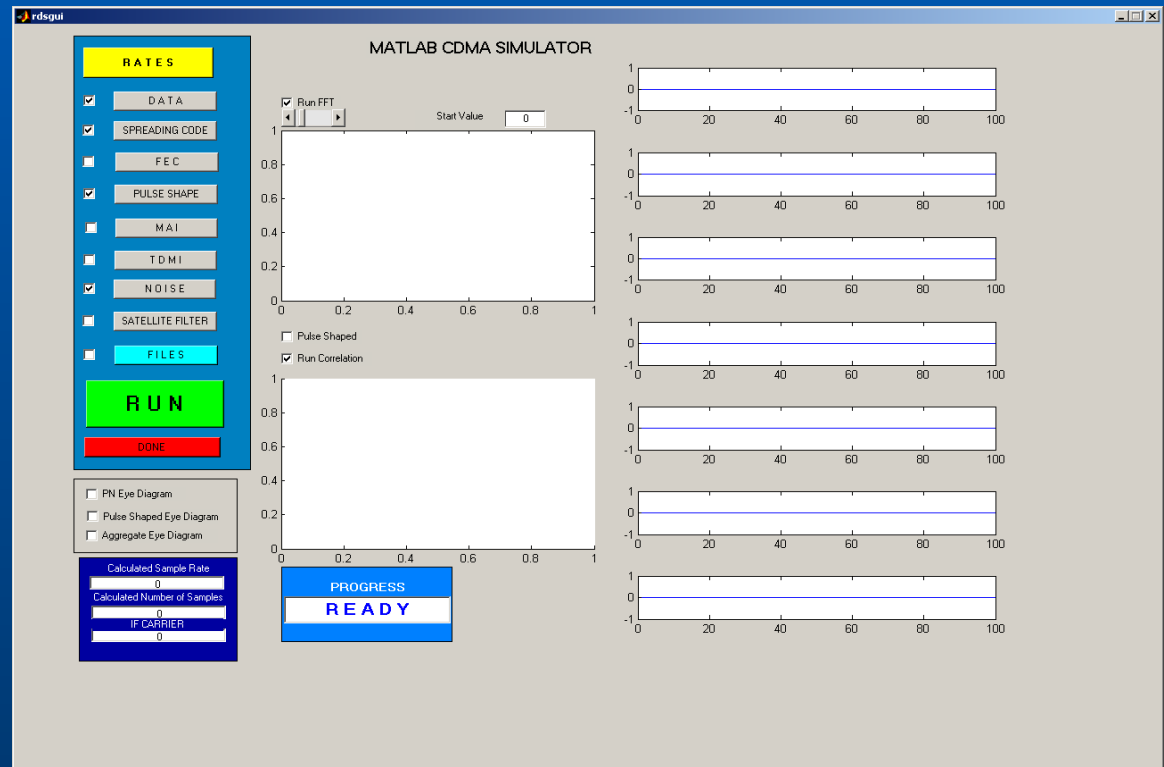


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# Matlab Test Signal Generation

- Written in Matlab
- TX GUI
- Flexible
- Data plots
  - Frequency Spectrum
  - Time Signals
  - Correlations



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# Flexible PN Settings

The image shows two overlapping software dialog boxes. The background dialog is titled "Spreading Code Sequence" and contains the following fields:

- Code Length: 31
- Tap A (BINARY): 10111
- Fill A (BINARY): 10000
- Tap B (BINARY): 10100
- Fill B (BINARY): 00000

The foreground dialog is titled "RATES" and contains the following fields:

- Chip Rate: 312953.125
- Chip Rate to Carrier Multiplier( 0 for baseband ): 16
- Samples Per Chip: 4
- Carrier Error: 0
- Delay in Samples: 0
- Attenuation Factor: 1

Both dialogs have "OK" and "Cancel" buttons at the bottom.



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# Data & FEC Settings

**DATA** [X]

DATA FRAME

1110001011100010111001100010000100101111100000111110101010111

Preamble Length

25

**Forward Error Correcting Codes Formulation** [X]

Convolutional Code (0: Non-systematic, 1: Systematic, 2: Turbo Code)

0

Convolutional Code Constraint Length (Must be between 3 and 9)

3

FEC Rate (0: 1/2, 1: 2/3)

0

Data Length (Info bits + tail bits for FEC)

50

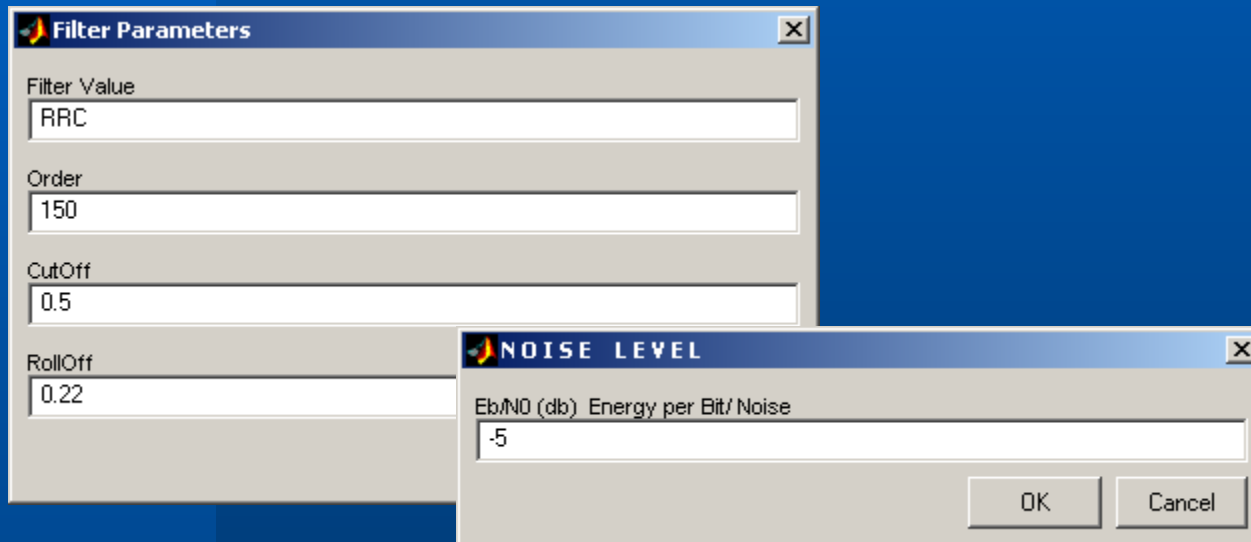
Variable Data Bit Length and Pattern? (0: No, 1: Yes)

0

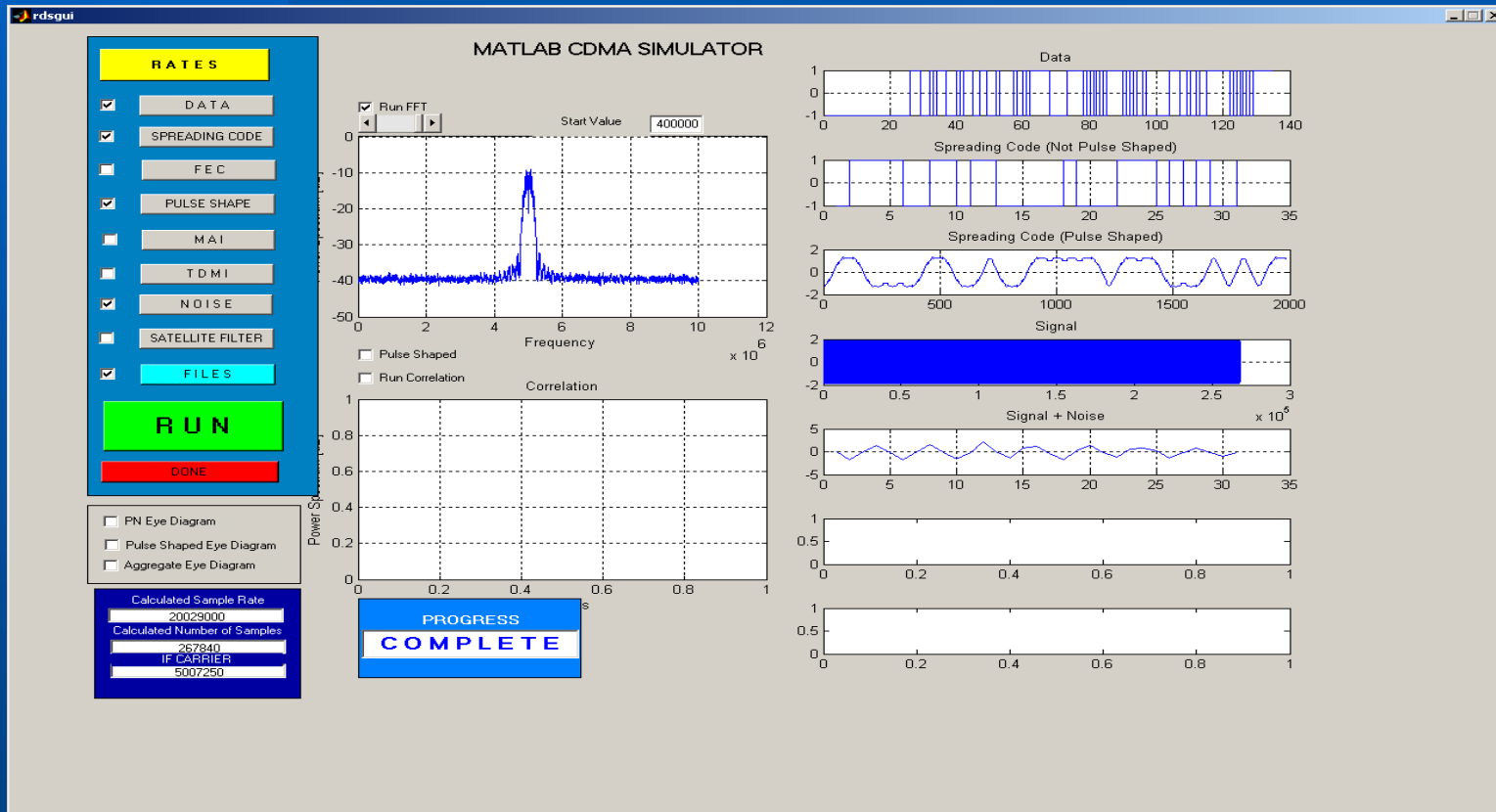
OK Cancel



# Pulse Shaping / Noise



# Signal Viewing

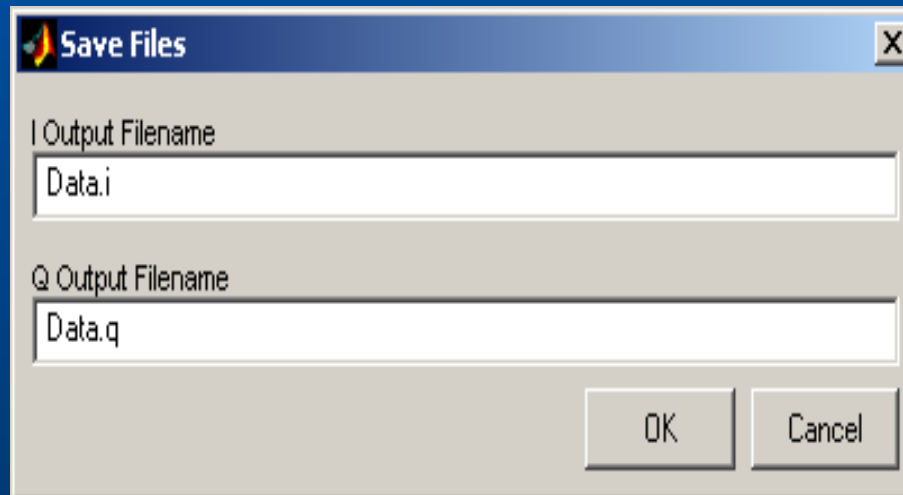


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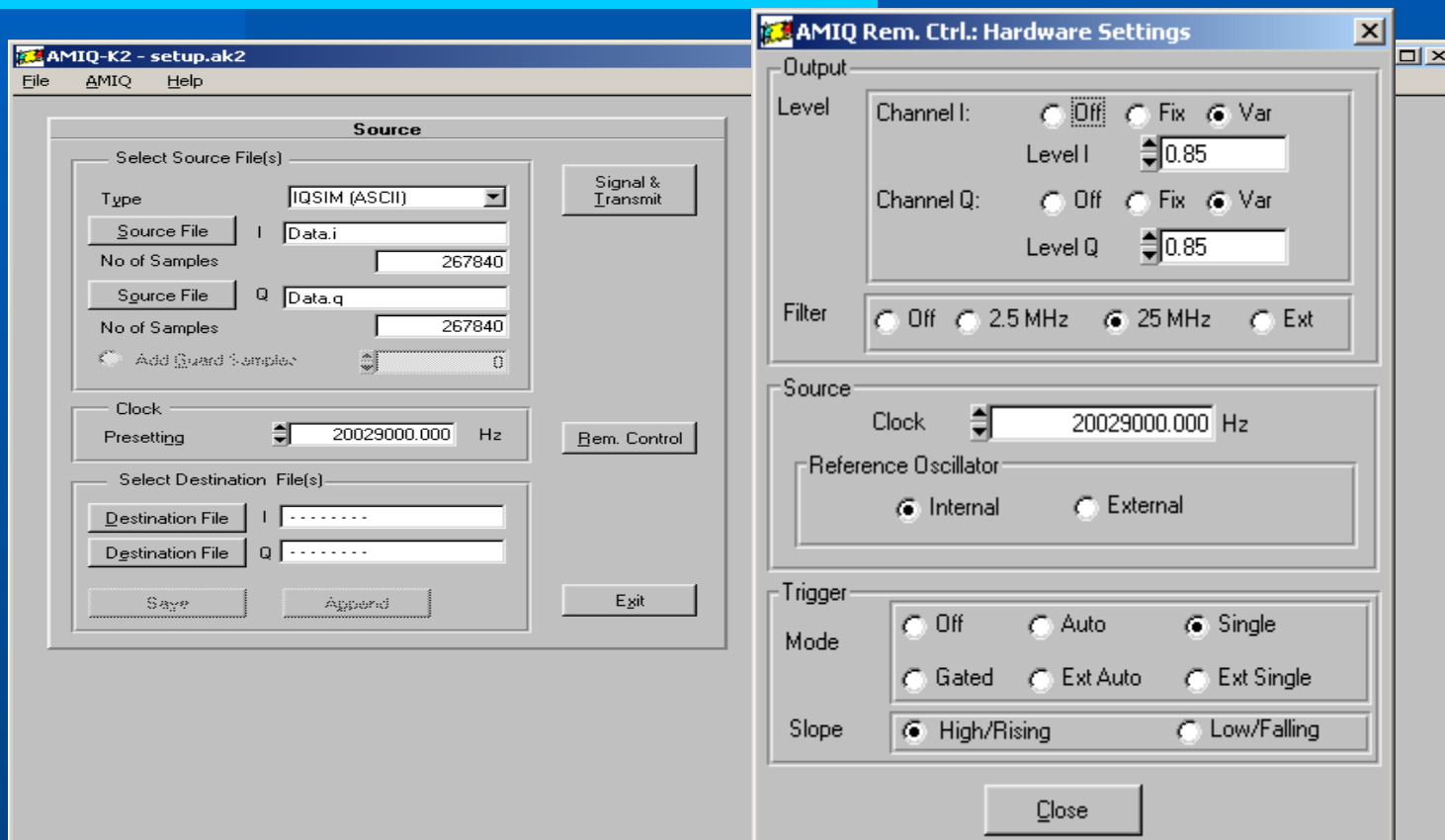
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# Signal Files

- Files can be saved and formatted for Rhode and Schwarz AMIQ generation



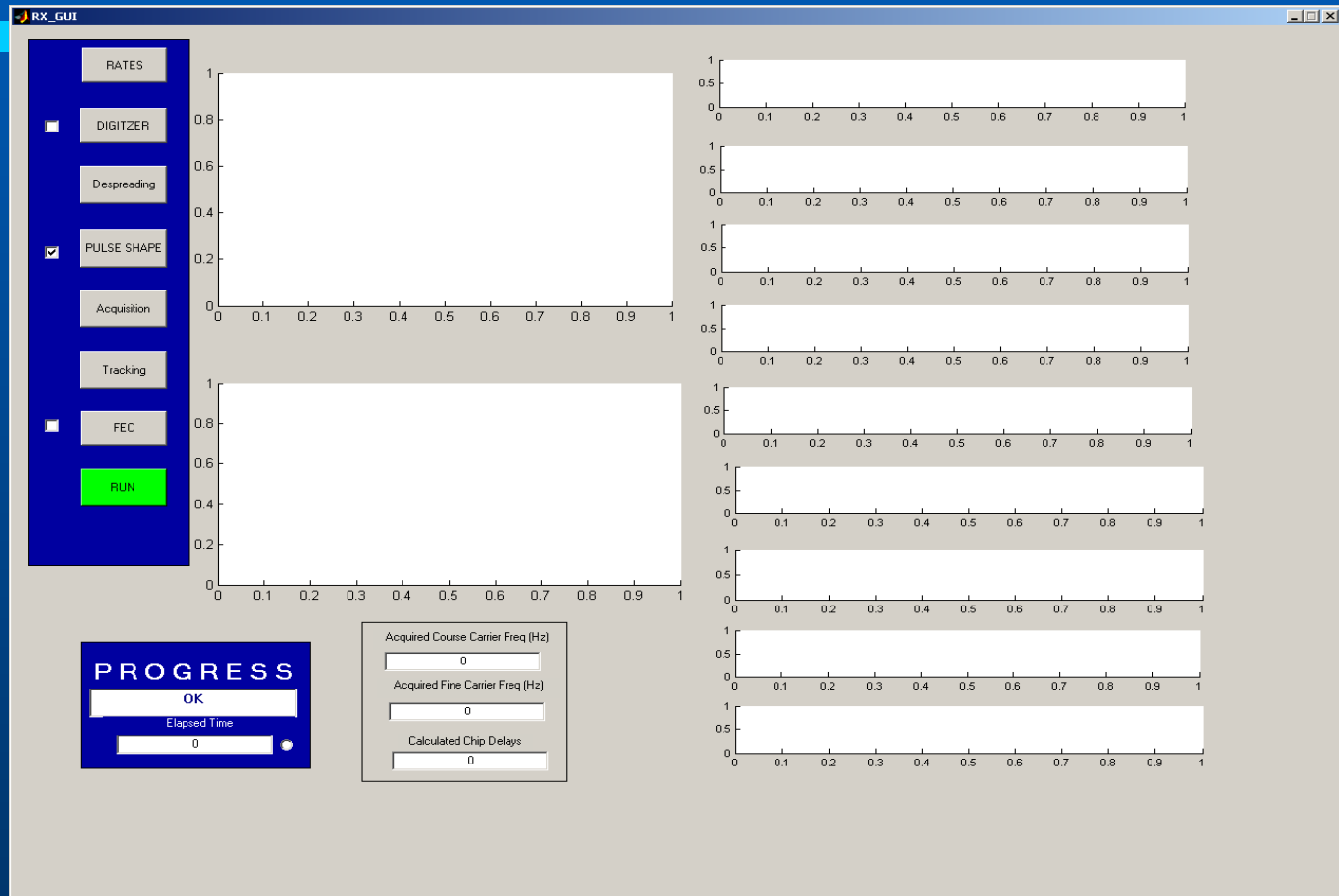
# Rhode and Schwarz AMIQ



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# Phase 1 Rx Simulation



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# Digitizer Set Up

- Gage digitizer program sets up like a digital oscilloscope through Matlab

**Gage Digitizer Board Setup**

Operation Mode  
2

Sample Rate  
20029000

CH A Range  
3

CH A Coupling  
1

CH B Range  
3

CH B Coupling  
1

CH A Impedance  
16

CH A Impedance  
0

E Range  
1

E Coupling  
1

Source  
1

Slope  
1

Level  
128

Source\_2  
1

Slope\_2  
2

Level\_2  
128

Depth  
267840

use\_multiple\_record  
0

use\_external\_clock  
1

external\_clock\_rate  
20029000

use\_cal\_table  
1

OK Cancel



# Rx Setup dialogs

The image displays four overlapping dialog boxes for receiver setup:

- RATES**:
  - Chip Rate: 312953.125
  - Chip Rate to Carrier Multiplier (0 for baseband): 16
  - Samples Per Chip: 4
- Forward Error Correcting Codes Formulation**:
  - Convolutional Code (0: Non-systematic, 1: Systematic, 2: Turbo Code): 0
  - Convolutional Code Constraint Length (Must be between 3 and 9): 3
  - FEC Rate (0: 1/2, 1: 2/3): 0
  - Data Length (Info bits + tail bits for FEC): 50
  - Variable Data Bit Length and Pattern? (0: No, 1: Yes): 0
- Spreading Code Sequence**:
  - Code Length: 31
  - Tap A (BINARY): 10111
  - Fill A (BINARY): 10000
  - Tap B (BINARY): 10100
  - Fill B (BINARY): 00000
- Filter Parameters**:
  - Filter Value: RRC
  - Order: 150
  - CutOff: 0.5
  - RollOff: 0.22





# Acquisition and Tracking

**Receiver Acquisition**

+Frequency Range  
1000

Number of Correlations to Average  
101

Acquisition Threshold  
1

Frequency Step  
250

Pullin BW  
500

Pullin resolution  
5

OK Cancel

**TRACKING FILTER**

B1  
50

Tracking Filter Damping  
0.7

dT  
0.001

K  
1256.6371

Number of Avgs  
4

Integration Frequency  
196

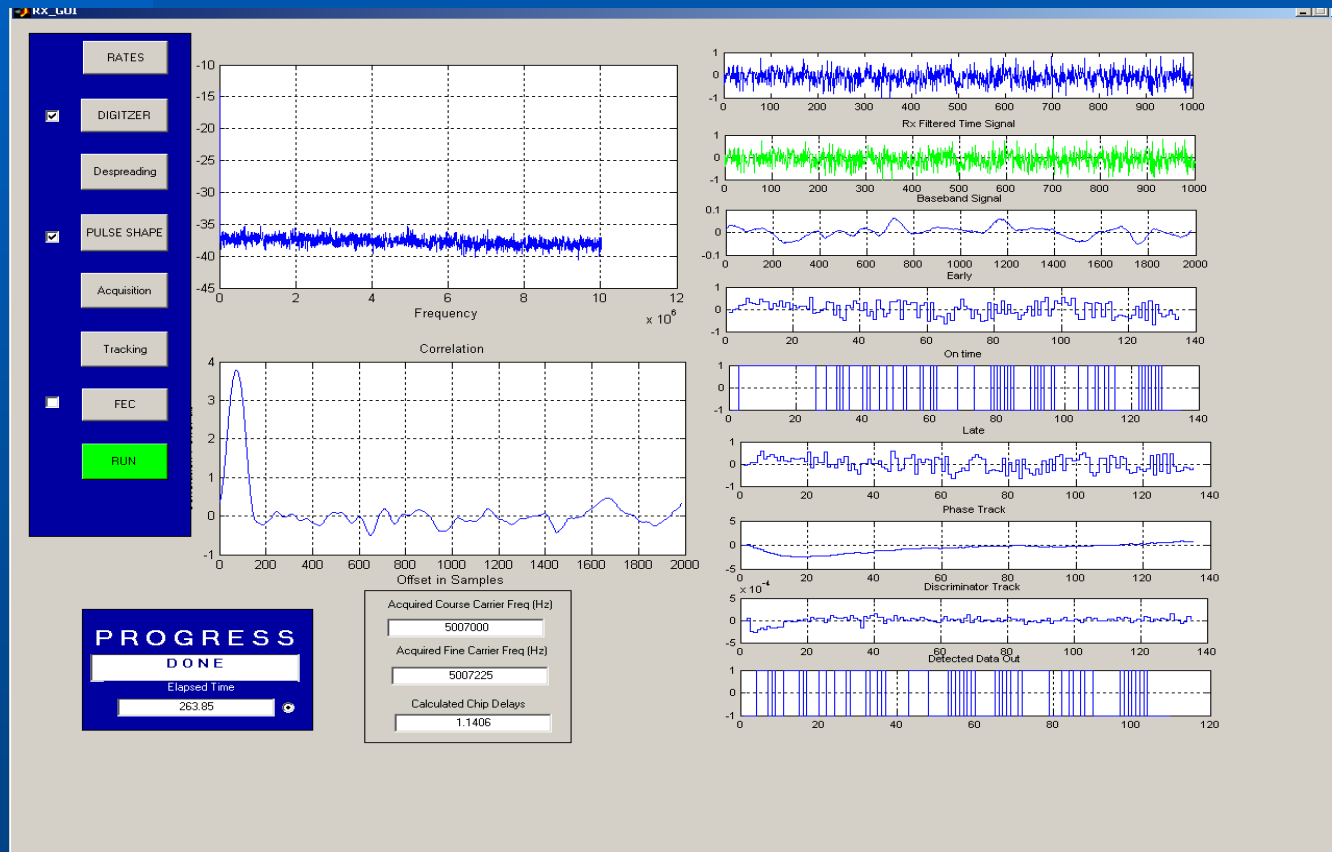
OK Cancel



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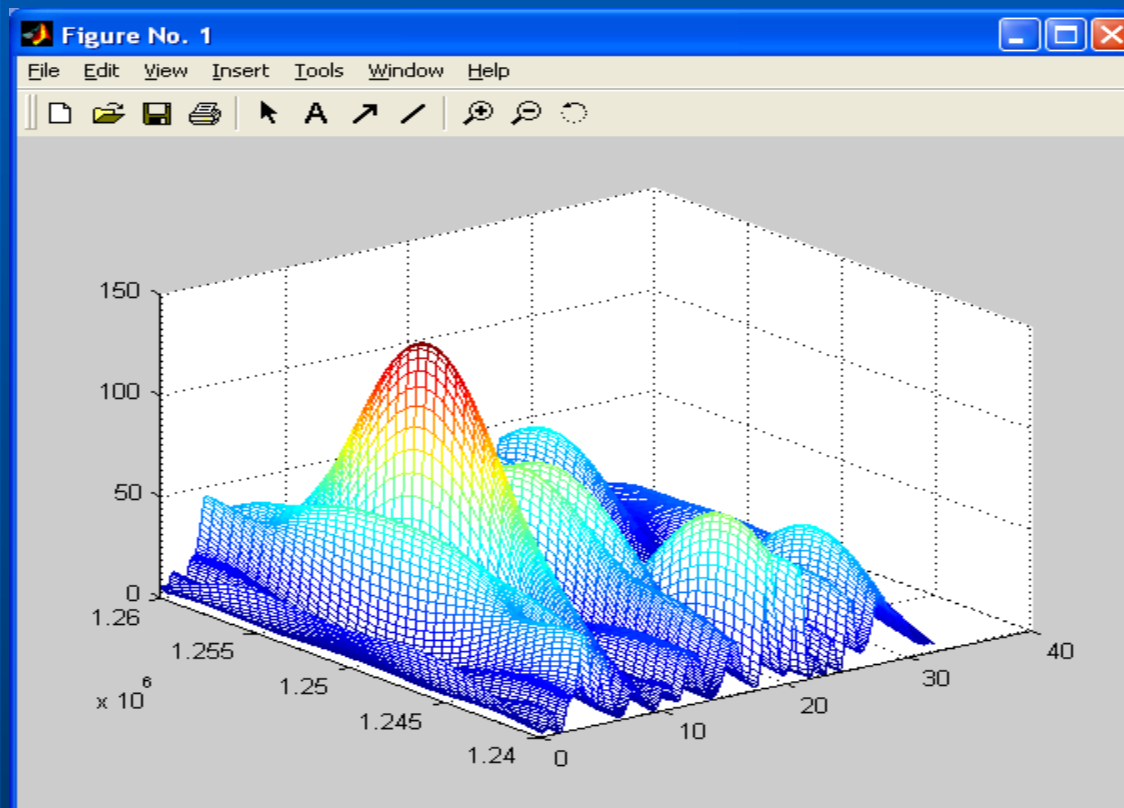
# Demodulator Results



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# 3D Correlation Results



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# Prototype Implementation

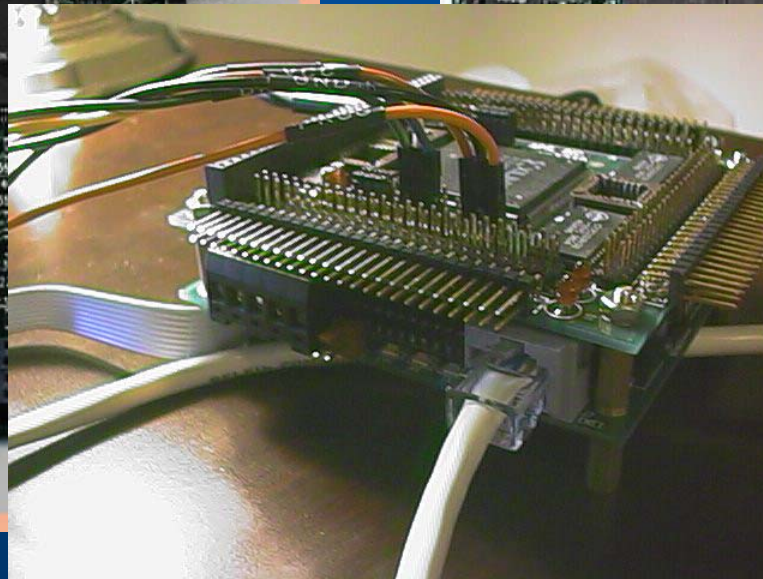
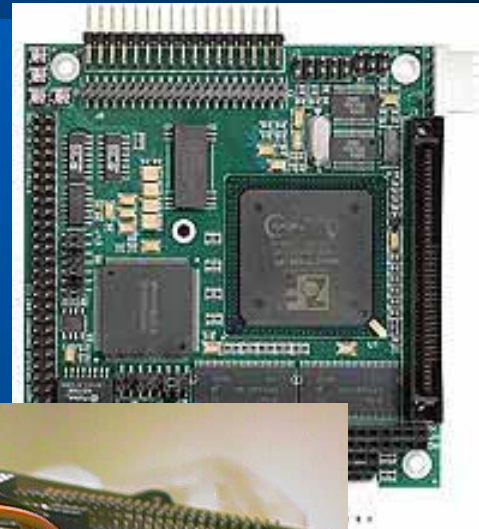
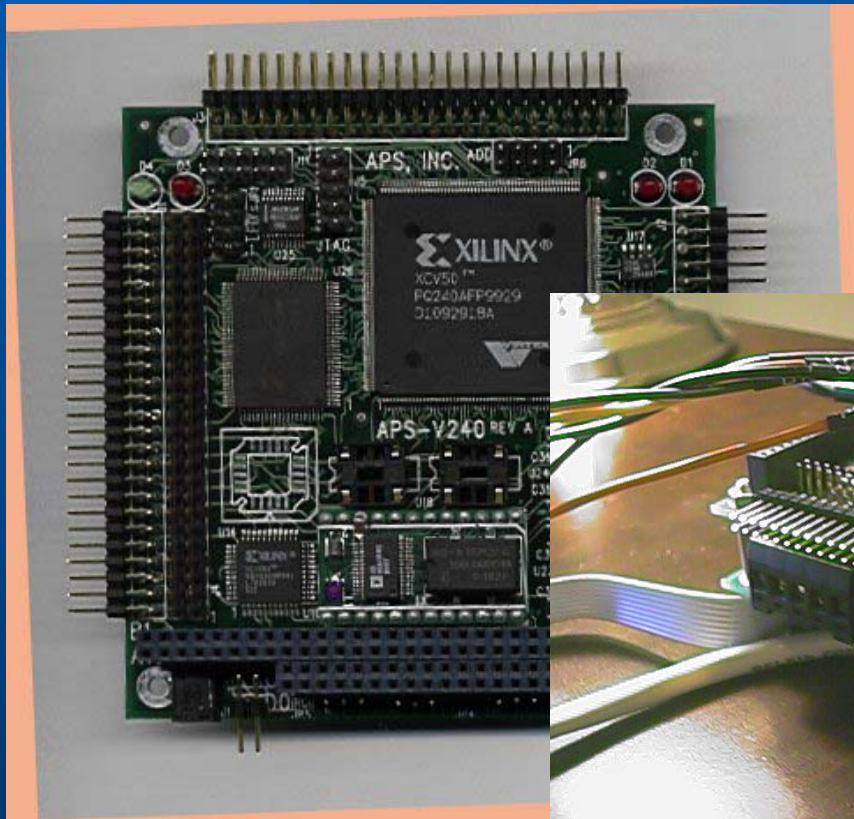
- **Phase 2:**

- **Transmitter Implementation**
  - **Modified Microcom Modulator**
  - **FPGA Daughter card handles Spreading**
- **Receiver Implementation**
  - **ASIC Tuner Front End**
    - **AGC**
    - **Down conversion**
    - **Pulse Shaping / Filtering**
  - **FPGA / VHDL PC104**
    - **Interference Cancellation**
    - **Correlation Acquisition\***
    - **Tracking**
    - **Sample clock control**
    - **Tracking\***
  - **Pentium PC104 Processor / C/++**
    - **Tracking/Acquisition \***
    - **FEC**
    - **Data Demodulation and forwarding**

\* Tracking and Acquisition trade offs will be implemented in FPGA and PC104



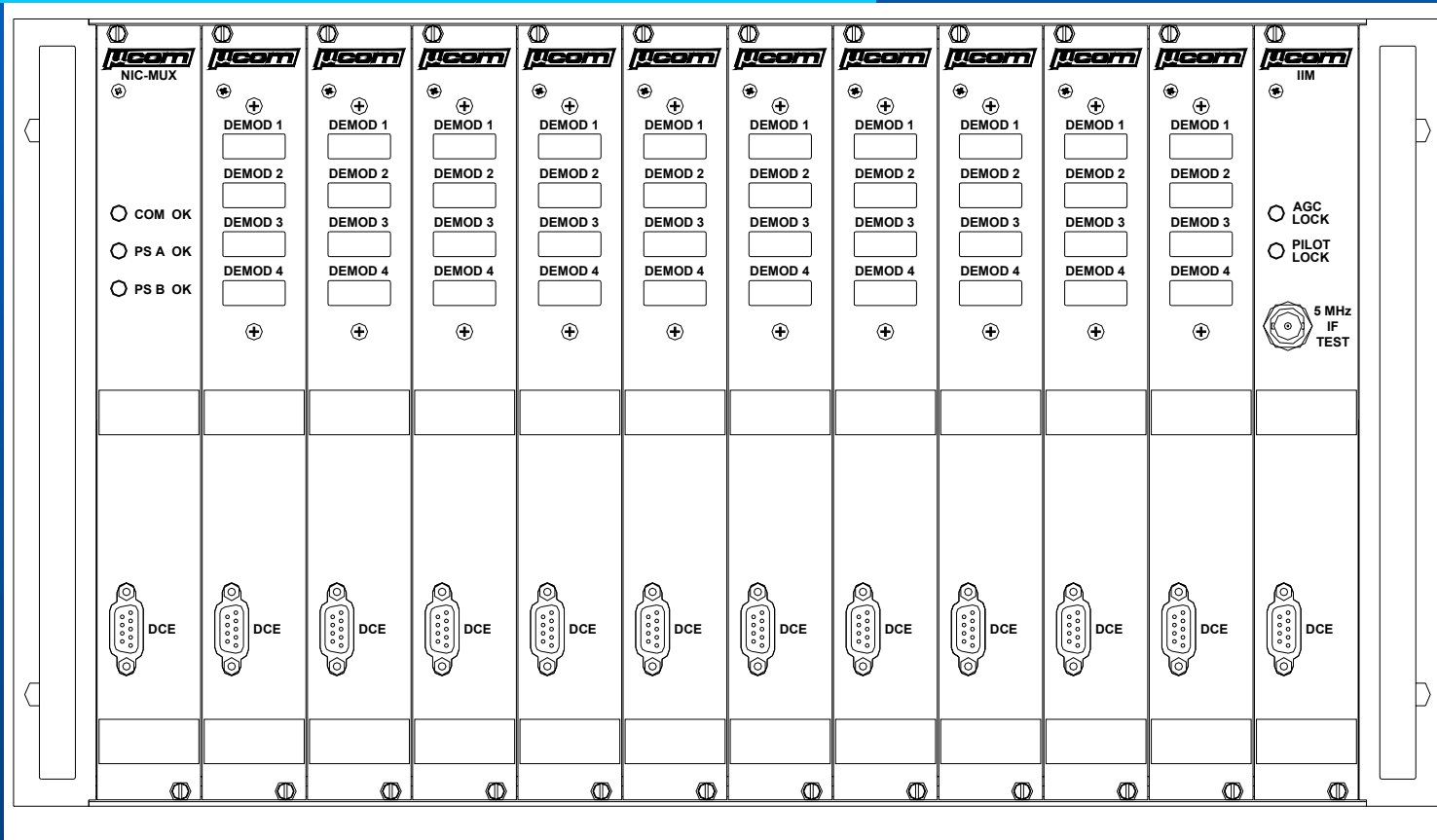
# Rapid Development



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# Integrated into existing GOES Equipment



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# Phase 2 System Integration

- **Tx CDMA functionality integrated via FPGA daughter card on existing Microcom HDR Modulator**
- **Rx CDMA functionality implemented into recently delivered Microcom Design DAMS NT system.**



# Expectations

- We are targeting around 50 CDMA users
- Expect to use ~312500 Hz chip rate
- R11 Gold Code PN Generators
  - 152.6 Hz data stream.
- Root Raised Cosine Pulse shaping
- Expect Software radio to be able to implement TDMA and or CDMA signals as well as others
- Expect Power control synchronous back channel to be eventually implemented ?
- System flexible enough to implement new features

**FOR MORE INFO...**

**Contact MICROCOM DESIGN**



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# Summary

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    - **Fully digital Matlab Preprocessed test signals**
      - Rhode Schwarz AMIQ
    - **Digitization of entire IF and post processing demodulation**
      - GAGE PC Digitizer
    - **System currently in place and working in Microcom Spaces**
  - **Phase 2 Evaluation System: Prototype Software Radio Approach**
    - **Modification of existing Microcom equipment**
    - **Real hardware- integrated into existing Microcom GOES Hardware**
    - **System partially designed and in the works.**

