EE 382: Introduction to Design

Beacon Finder and Identifier Robot

Department of Electrical Engineering
New Mexico Institute of Mining and Technology

January 15, 2013

Outline

Course Overview

Instructors:

- Greg Mansfield
- Kevin Wedeward

Time/Place:

- TR 2:00pm - 5:00pm
- Cramer 203 for lectures and presentations
- Workman 116/187 for work on project

Course Overview (cont.)

Prerequisites:

- EE 308 and EE 308L (microcontrollers)
- EE 321 and EE 321L (analog electronics)
- EE 333 (electricity and magnetism)
- EE 341 (signals and linear systems)
- Declared electrical engineering as a major

Course Overview (cont.)

Goals: Students will

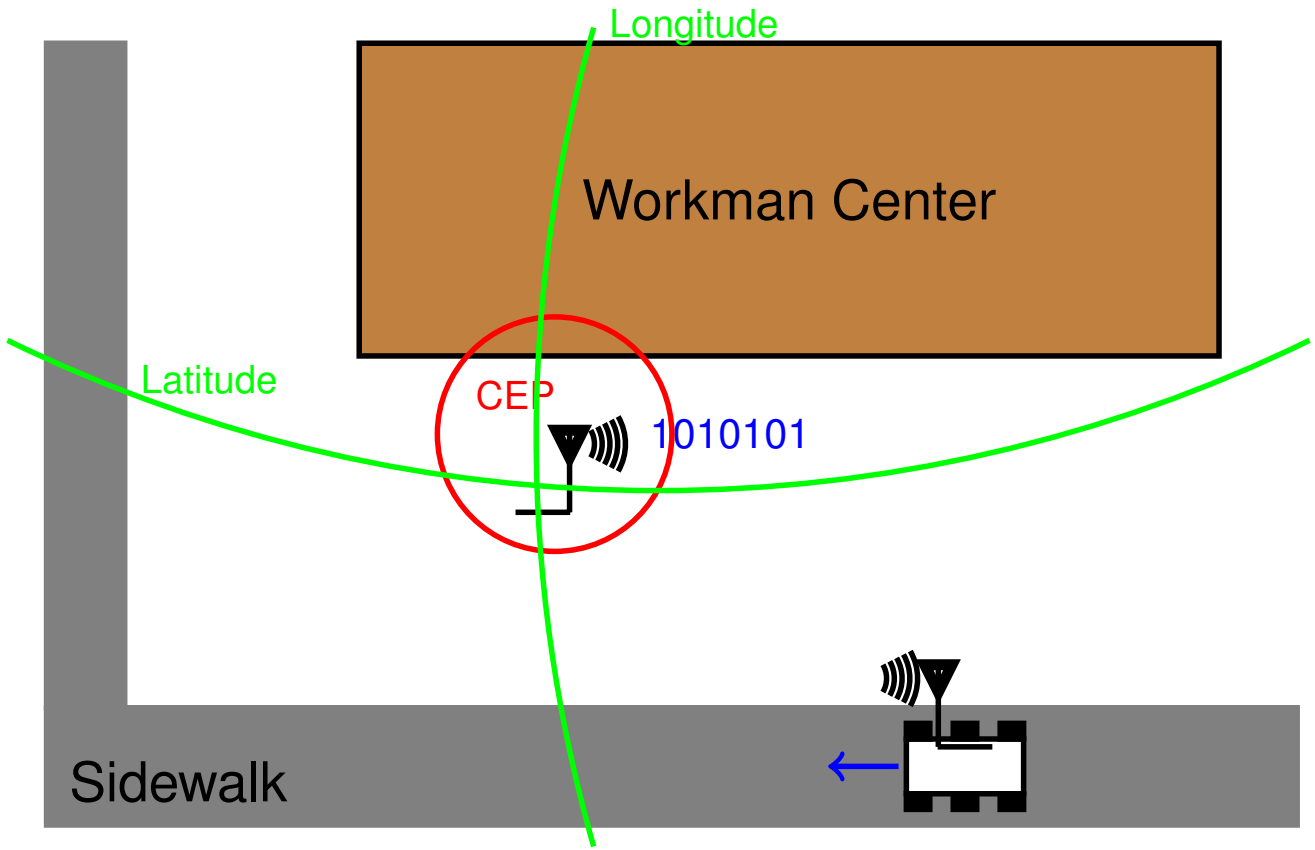
- work in teams,
- implement key aspects of a design process,
- design and build a prototype electronic system,
- conduct experiments to characterize and verify design,
- communicate aspects of the design process through oral presentations and written documents, and
- manage the design process.

Course Overview (cont.)

Project: Outdoor robot to remotely locate and identify RF beacon

- Design an outdoor robot capable of navigating a given, unobstructed area to remotely locate a RF beacon that has an identifier encoded via Frequency-shift keying (FSK).
- Location of the beacon will be computed as longitude and latitude along with a metric of error, and the beacon's identity will be decoded.

Course Overview (cont.)



Course Overview (cont.)

Grading:

- Statement of Work - 10%
- Conceptual Design Review (Presentation) - 10%
- Mid-term Design Evaluation - 20%
- Final Project Evaluation - 40%
- Final Design Presentation - 10%
- Demonstration for Faculty, Family and Friends - 0% (for fun)
- Final Report (including electronic version) - 10%
- Individual grades will be assigned; each student must participate in each graded-component of the course to pass the course.

Course Overview (cont.)

Parts provided:

- Dagu Wild Thumper 4WD all-terrain chassis
- Dagu Wild Thumper 6WD all-terrain chassis
- 18v15 Pololu high-power motor drivers
- 18v25 Pololu high-power motor drivers
- ZFL-2500+ Mini-Circuits 500-2500 MHz amplifier
- ZAM-42 Mini-Circuits 1500-4200 MHz frequency mixer
- BBP-10.7+ Mini-Circuits 9.5-11.5 MHz bandpass filter
- ZX95-2400A+ Mini-Circuits 2000-2400 MHz voltage controlled oscillator
- 2S1P EP Buddy Lithium Iron Phosphate (LiFe) 6.6 V battery pack
- CellPro 4S FMA Direct battery charger (to be shared by class)

Course Overview (cont.)

Budget

- Each team will receive a budget of $325.
- Use order form to purchase items through the department; fill it out, have it signed by instructor and then ask secretary (Carrol) to place.

Suggested Suppliers:

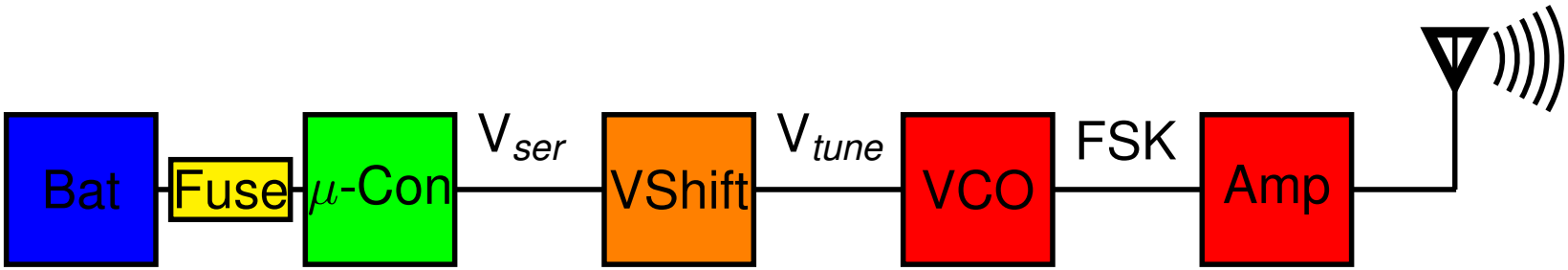
- Acroname Robotics
- Digi-Key
- Mini-Circuits RF/IF & Microwave Components
- Pololu Robotics & Electronics
- SparkFun Electronics

Course Overview (cont.)

Teams: TBD - bring written preferences on Thursday

Beacon

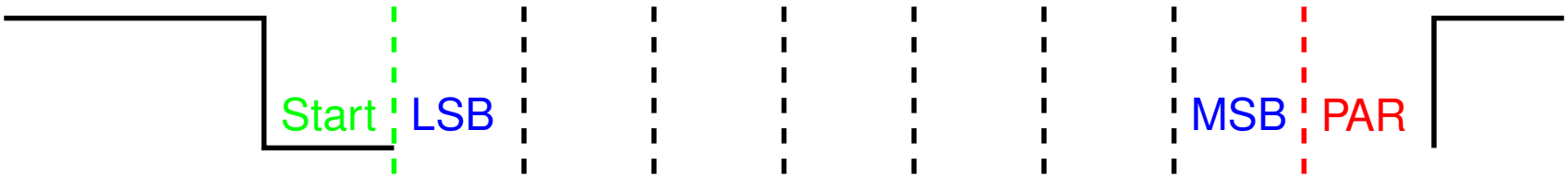
Beacon employs Frequency Shift Keying (FSK) modulation of serial message/identifier.



Beacon - Serial Stream

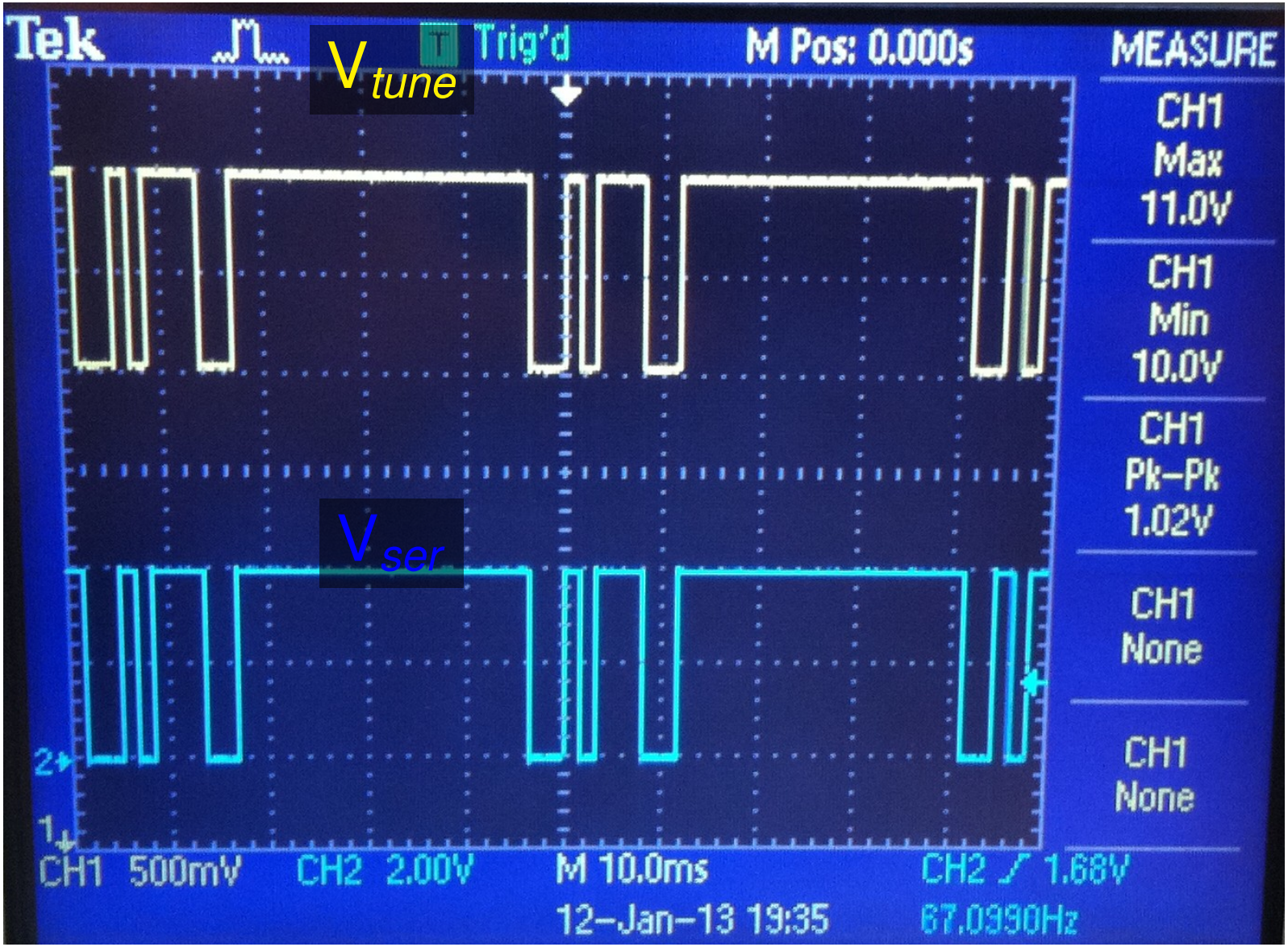
Serial 7-bit at a Baud rate of 600 with even parity bit.

- Baud rate - each bit in stream will be of length 1/600 seconds
- Start bit - 0 (after 1 for awhile)
- Message/identifier sent LSB first
- Even parity - last (8th) bit transmitted will make number of ones in 7-bit identifier/message even



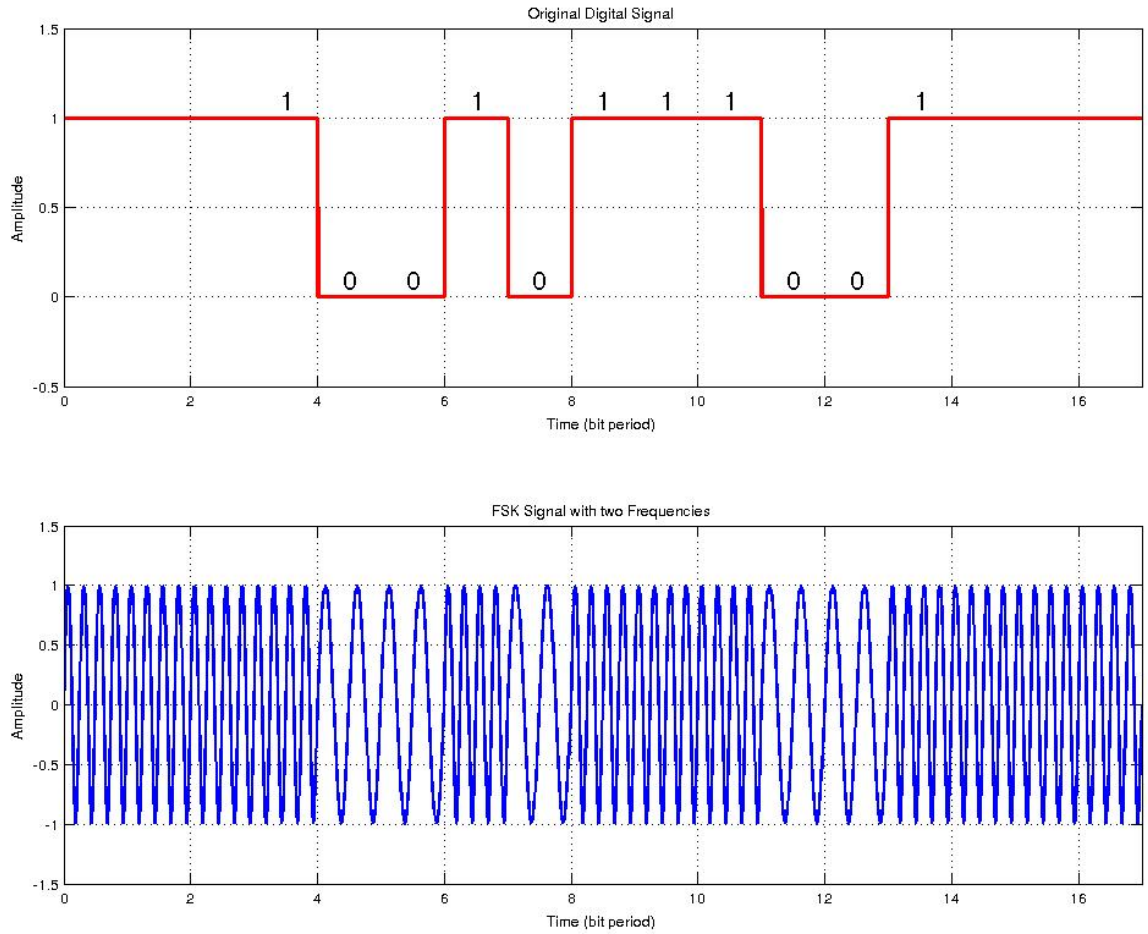
Beacon - Serial Stream (cont.)

7-bit identifier sent: 0111010



Beacon - FSK

FSK uses VCO to generate two sinuoids of different frequencies that correspond to 0s and 1s in serial stream



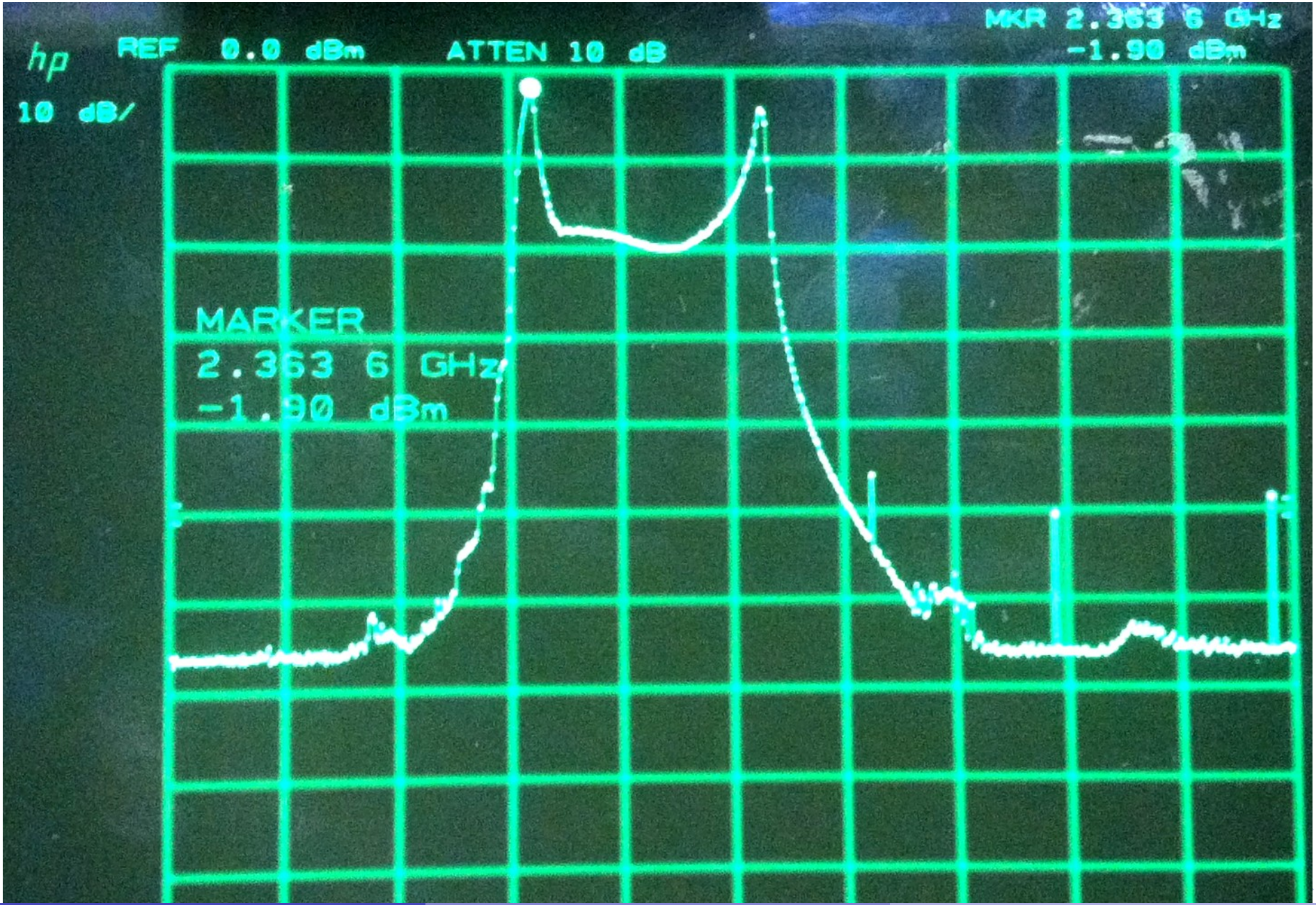
Beacon - FSK (cont.)

Recall Fourier Transform of sinusoid

$$f(t) = \cos(\omega_0 t) \Leftrightarrow F(\omega) = \pi(\delta(\omega - \omega_0) + \delta(\omega + \omega_0))$$

and that our FSK is made up of two (truncated/windowed) sinusoids of different frequencies.

Beacon - FSK


hp
REF 0.0 dBm
ATTEN 10 dB
MKR 2.363 6 GHz
-1.90 dBm
10 dB/
MARKER
2.363 6 GHz
-1.90 dBm

RF Decoder and Direction Concepts