Satellite Communications

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Presented to
RF, Microwaves, and Photonics Club
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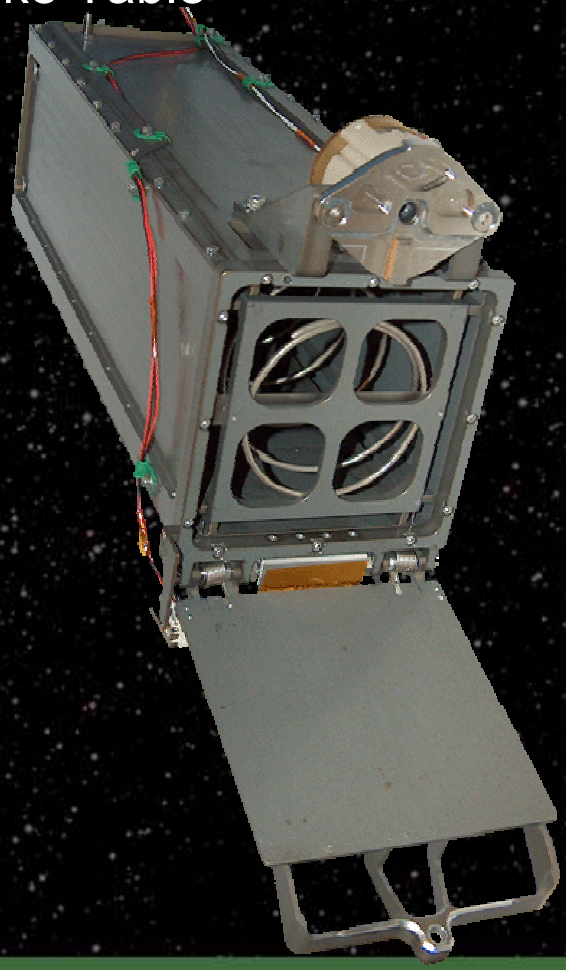
PolySat/CubeSat Background

PolySat

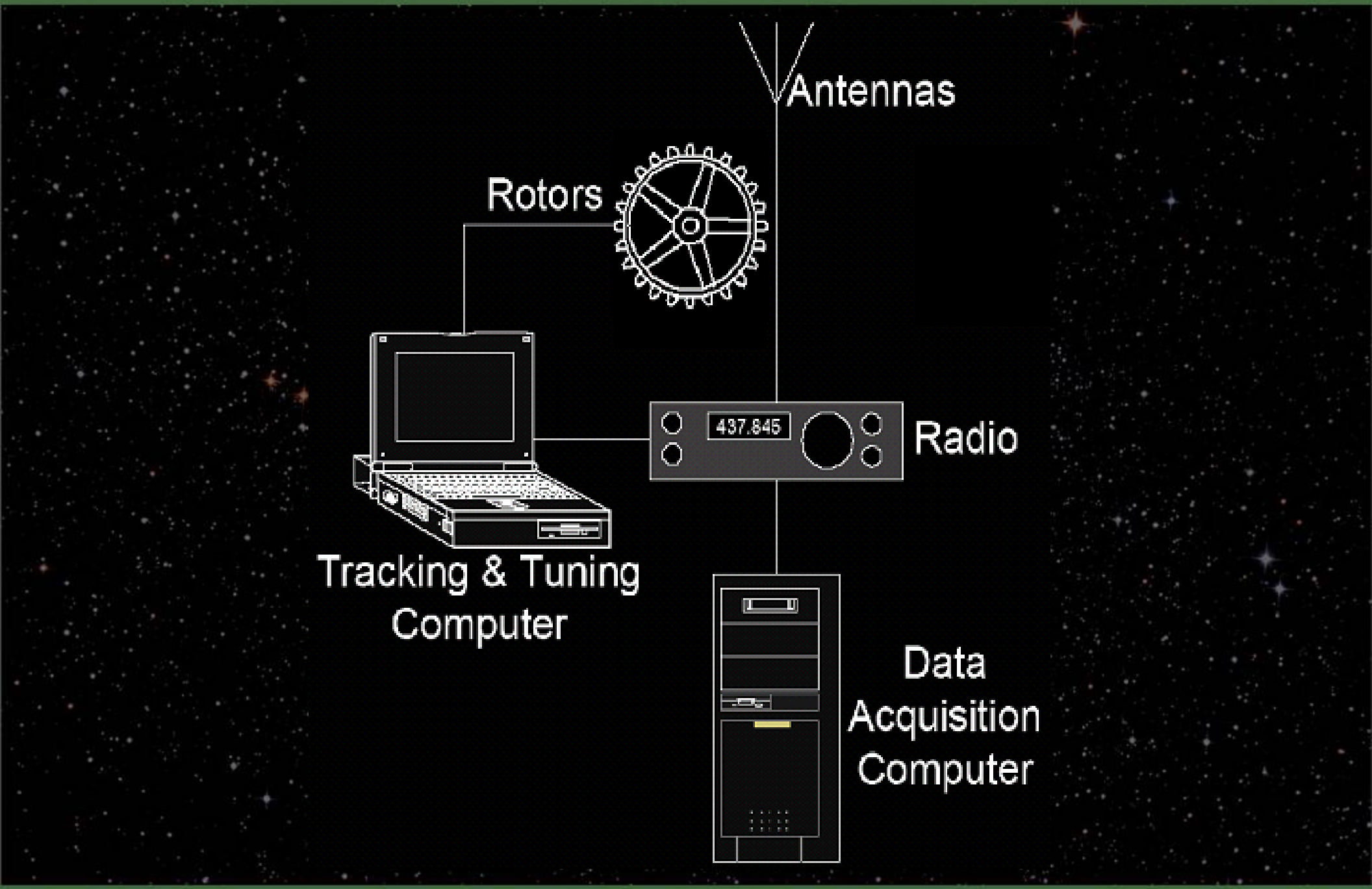
- Builds satellites
- Involved with creating a global Ground Station Network

CubeSat

- Builds P-POD
- Organizes launch opportunities
- Thermo Vac
- Shake Table



A Typical Earth Station



Two Earth Stations

- Two earth stations will be needed to support the two satellites
- Either station can communicate with either satellite
- The two stations are mirrors of each other, except the transceiver and antenna

Transceivers

- Yeasu FT-847 and Icom IC-910
- 50 Watts output power
- Fully Doppler shift controlled

Rotors

- Yeasu G-5500
- Full azimuth and elevation
- Computer controlled via MacDoppler Pro

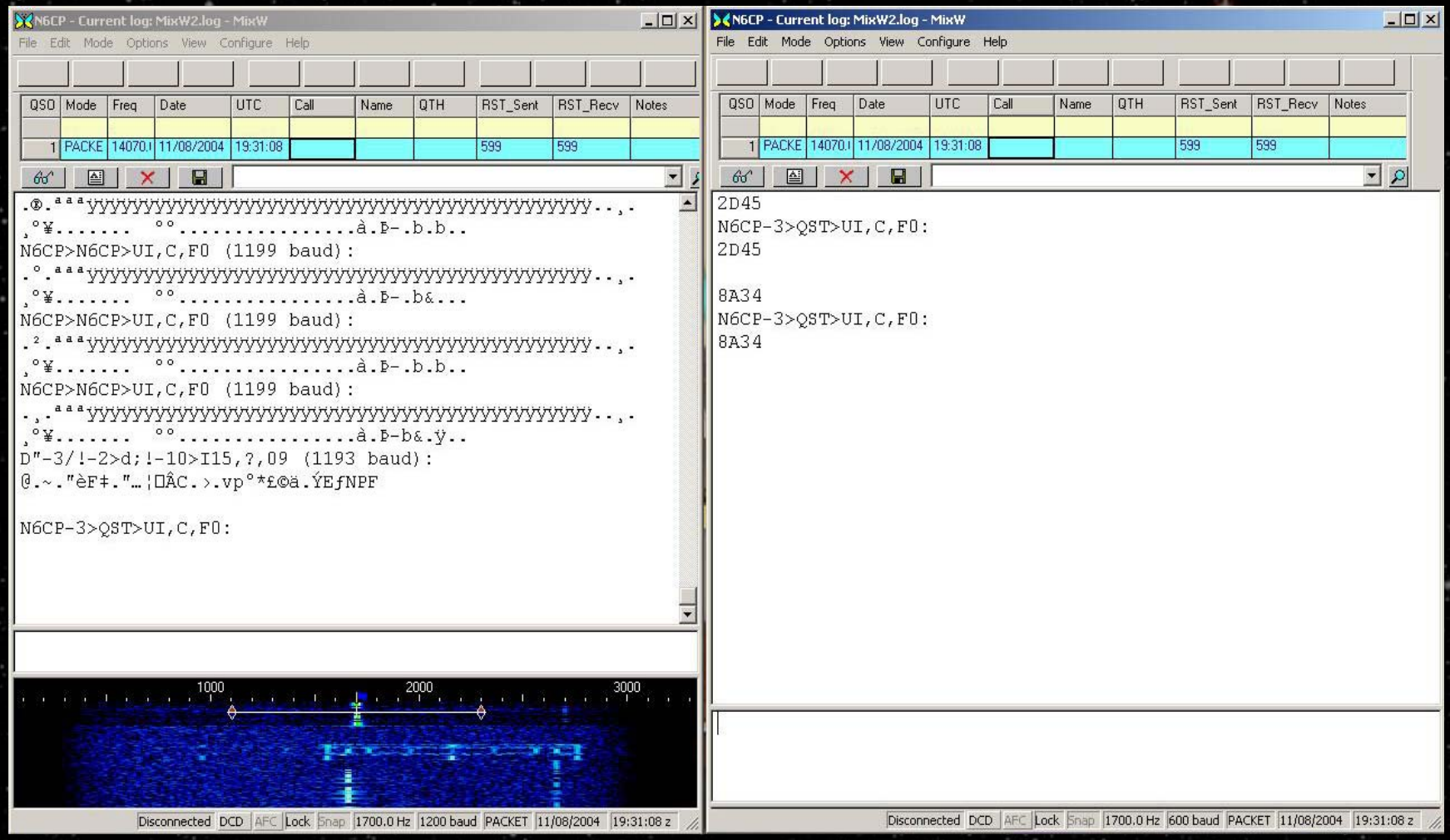
Frequency and Rotor Control

- MacDoppler Pro is used on Macintoshes to control the rotor movement and tune the radios for Doppler shift
- Very reliable and easy to use

Data Acquisition

- Software TNCs are used to decode the AX.25 packets
- The data will be decoded and stored on the computers, and audio files will be recorded as well
- These computers will also be used to command the satellite

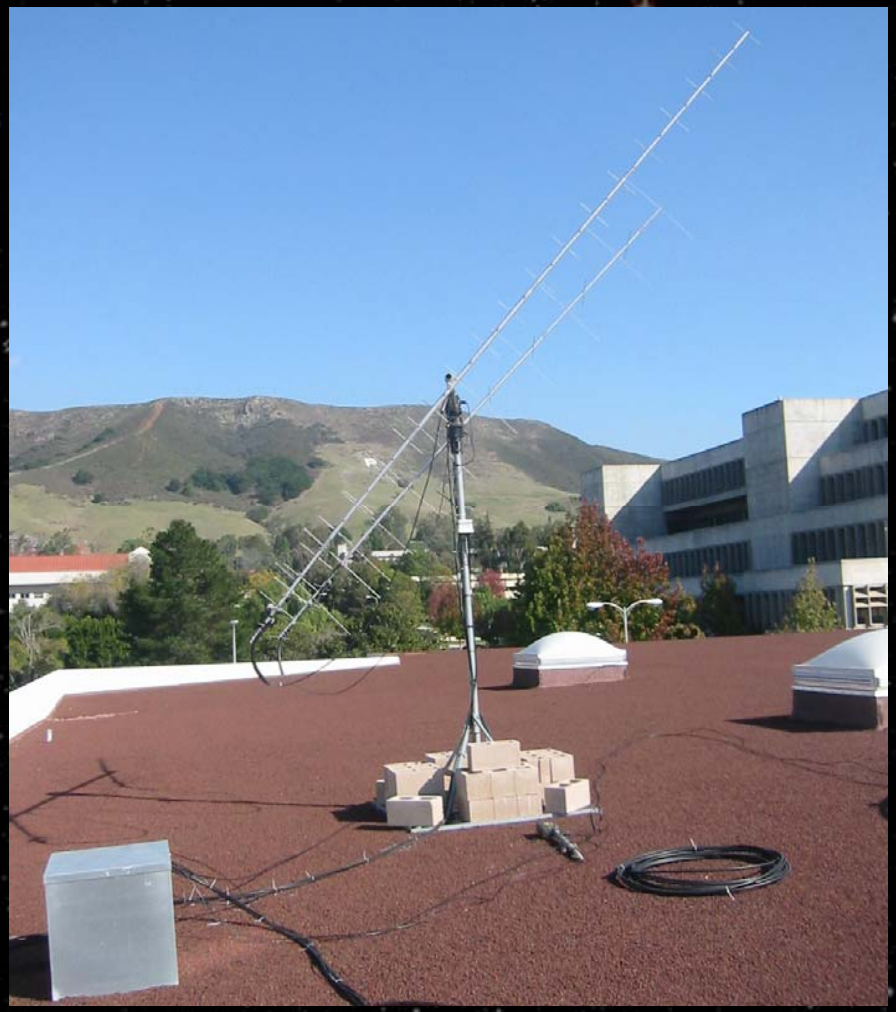
Data Acquisition



- We use MixW2, a software TNC, to decode the transmitted data
- The modulation scheme is 1200 baud FSK AX.25 with a CW beacon
- A small software program will be written to display the decoded information in an orderly manner

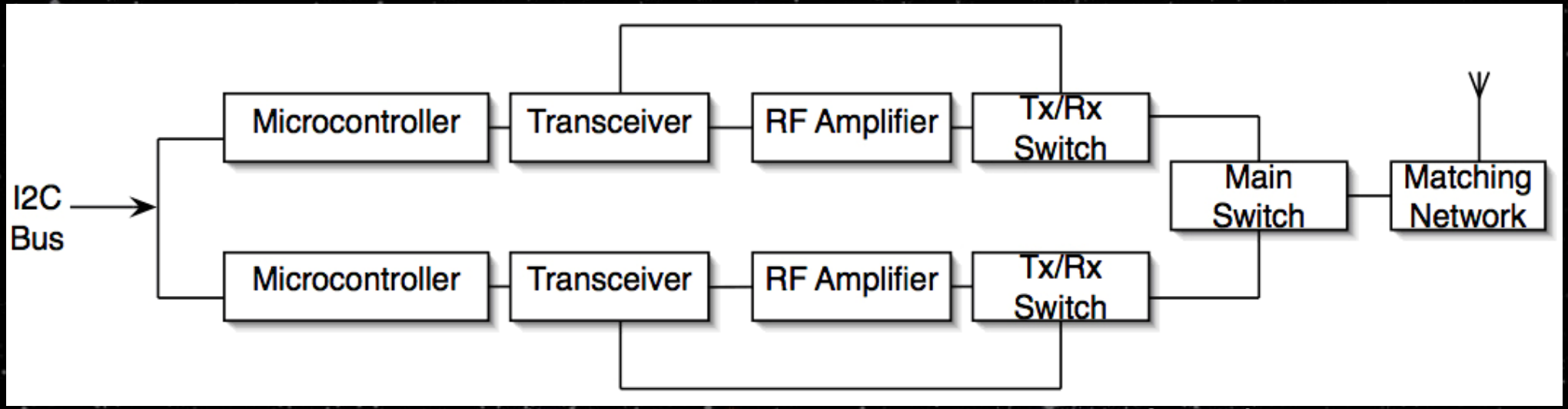
Antennas

- 437MHz yagi
- 13 dB gain
- 10 feet long
- 30 ˚ beamwidth



- 437MHz yagi
- 16 dB gain
- 20 feet long
- 21˚ beamwidth

Satellite Transceiver

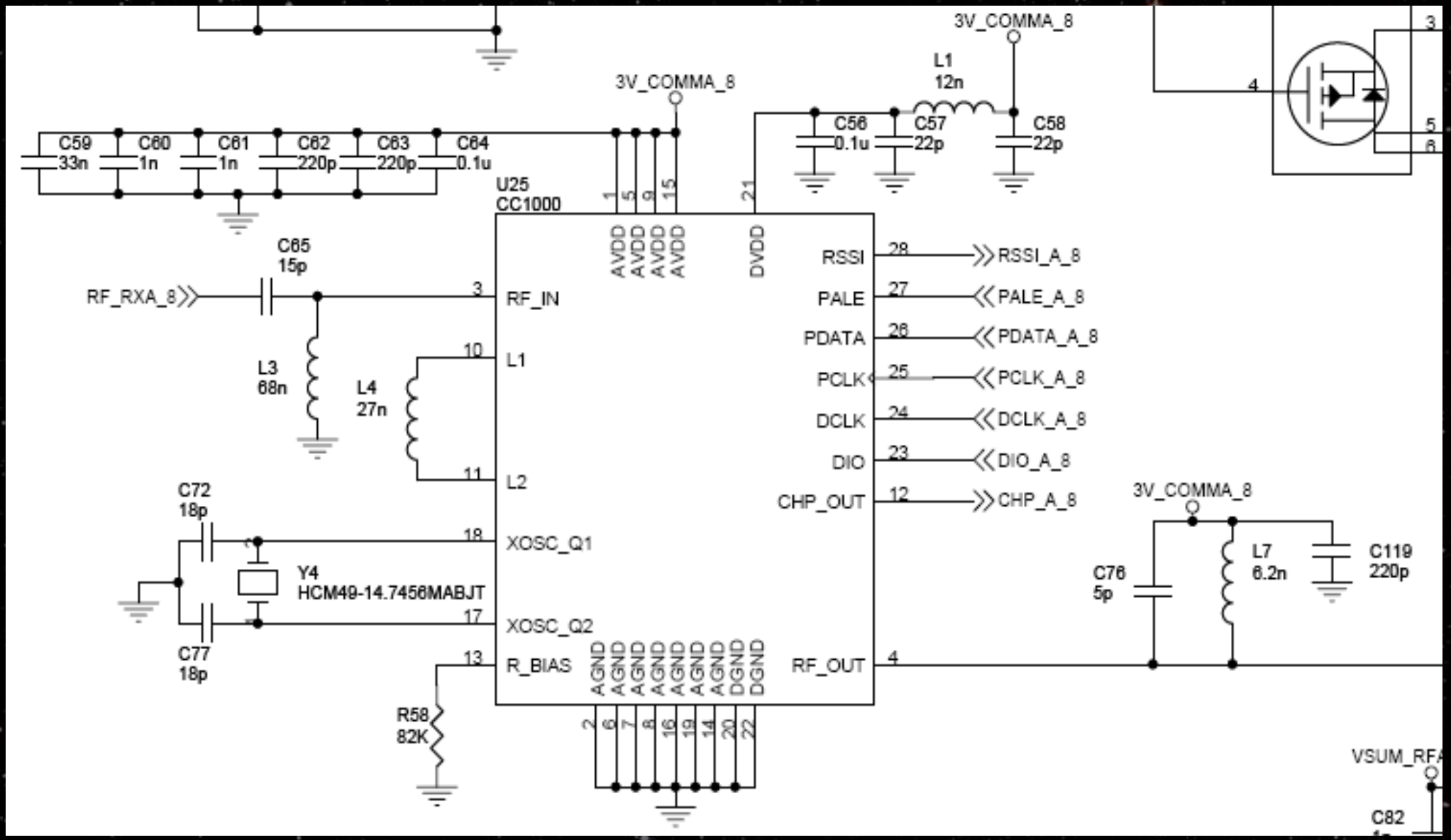


Graphic from Derek Huerta's Thesis

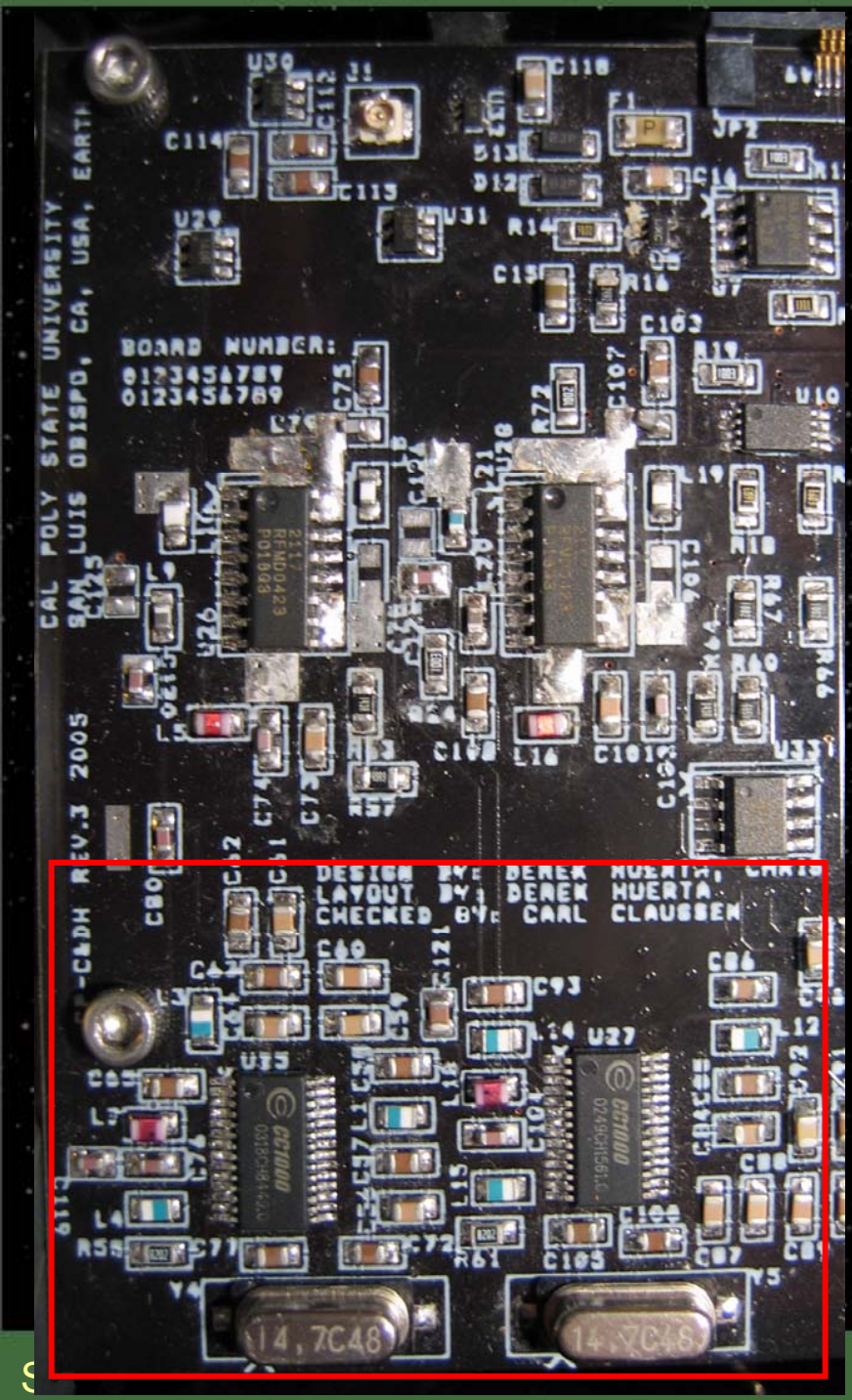
- ~ 850 mW
- 436-438 MHz
- 1200 baud FSK

- Upgrade to 9600 baud
- Upgrade to CC1020
- Upgrade to new RF amplifier

Satellite Transceiver

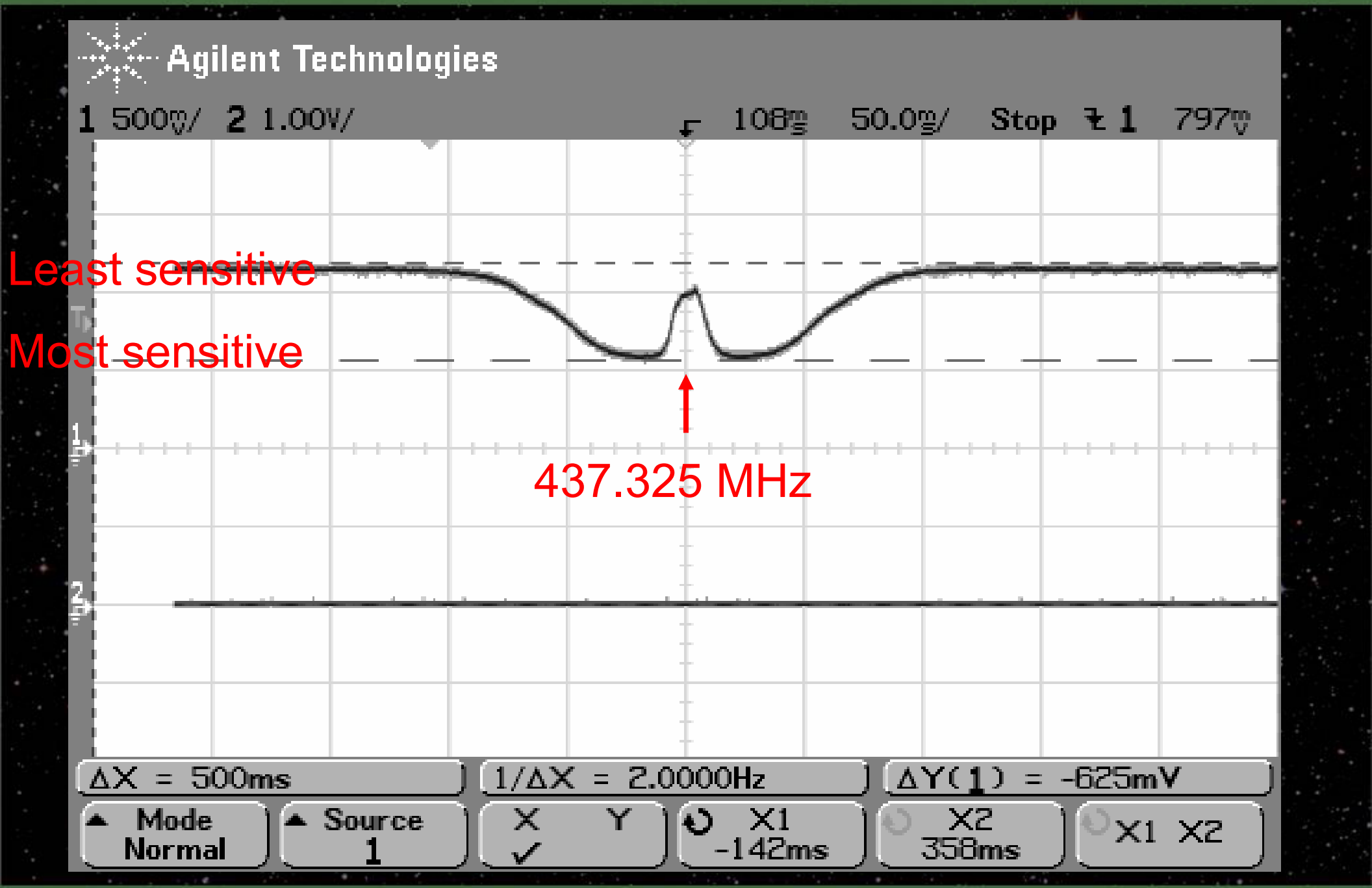


Satellite Transceiver

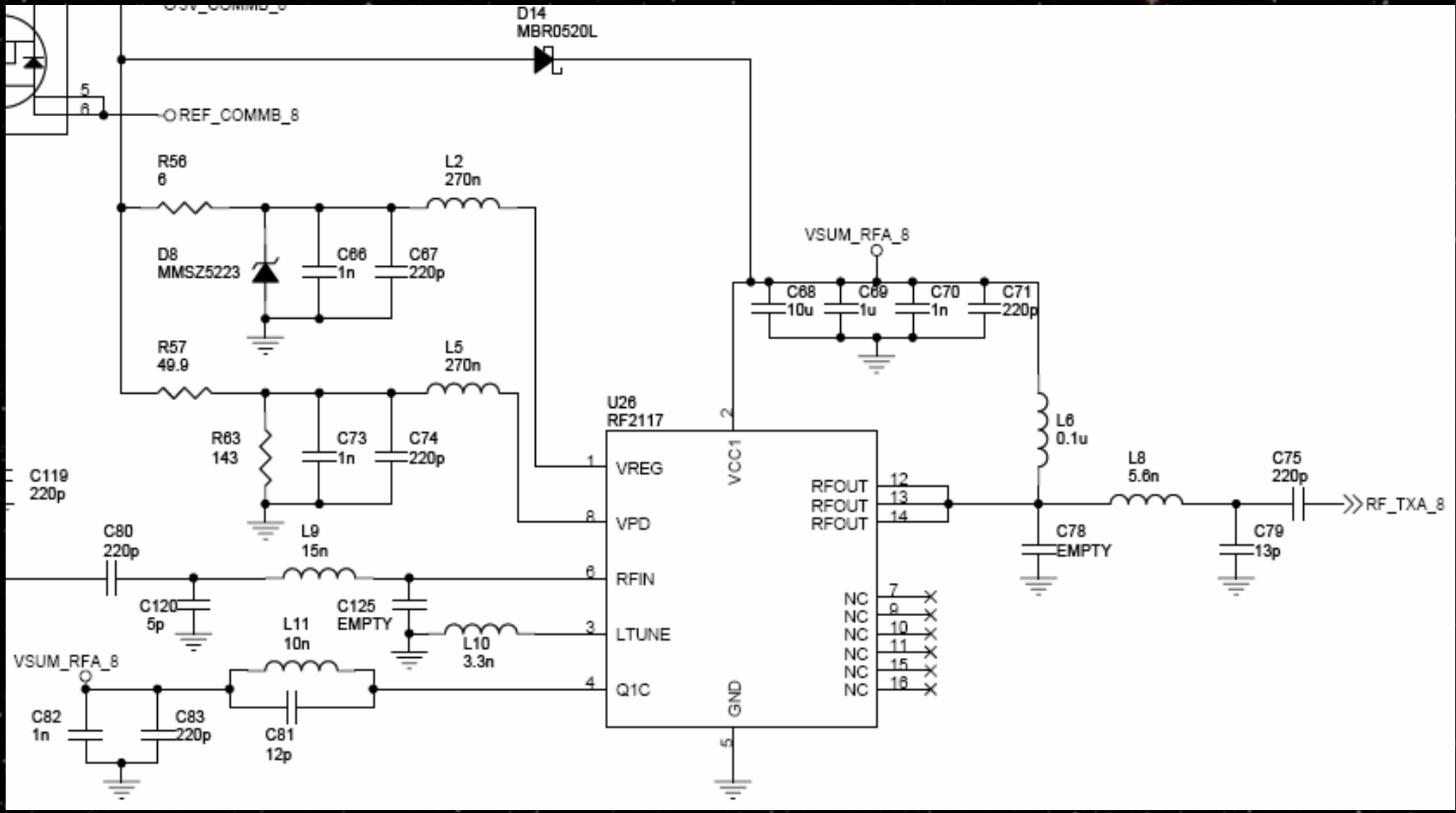


- CC1000
- Designed for short-range communication such as keyless entry, garage door, RC planes/cars
- 300 to 1000 MHz
- FSK up to 78.6 kBaud
- -20 to +10 dBm output power
- 140 Ω output impedance at 433 MHz
- 70 – j26 input impedance at 433 MHz
- -110 dBm receive sensitivity

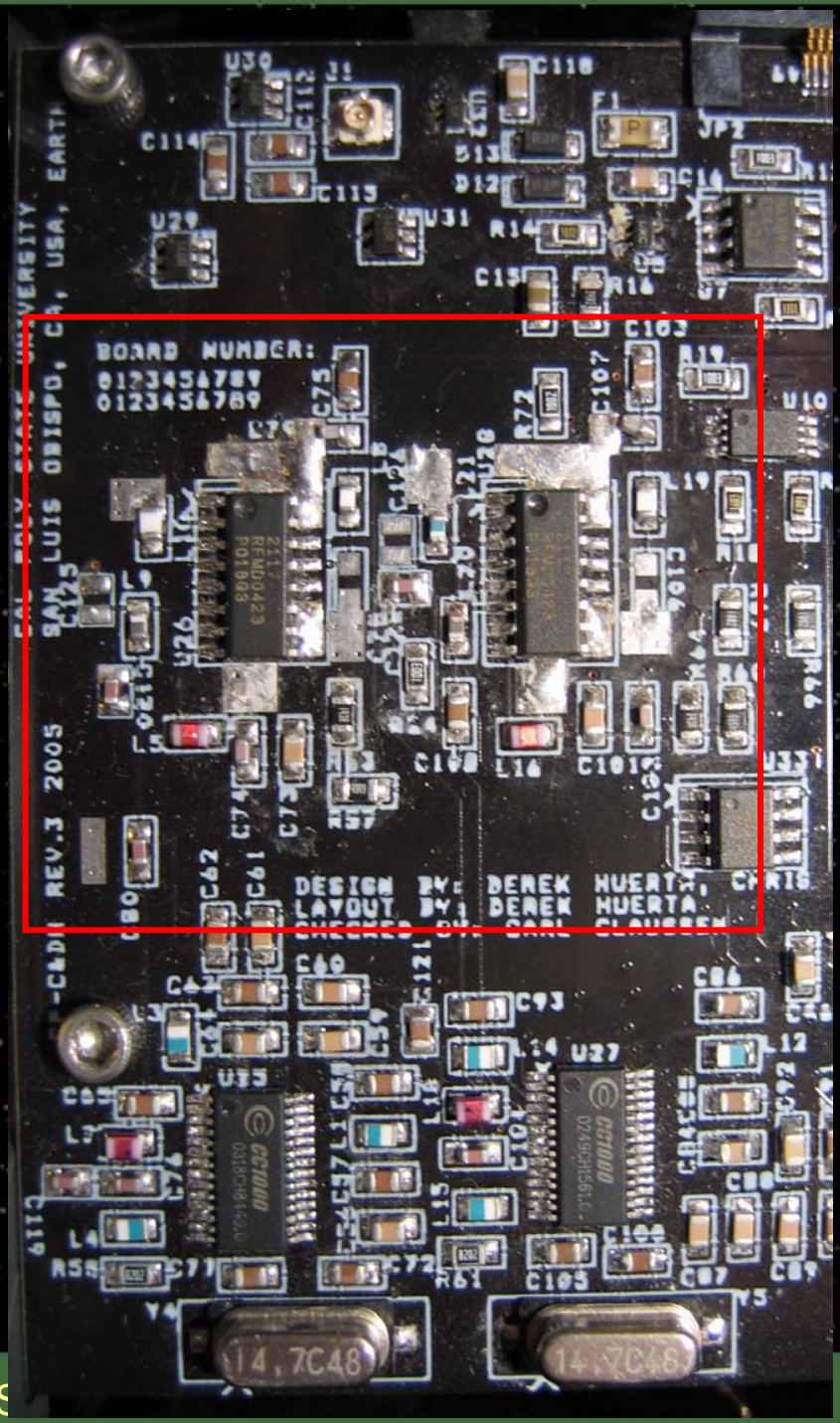
Satellite Transceiver



Satellite RF Amplifier

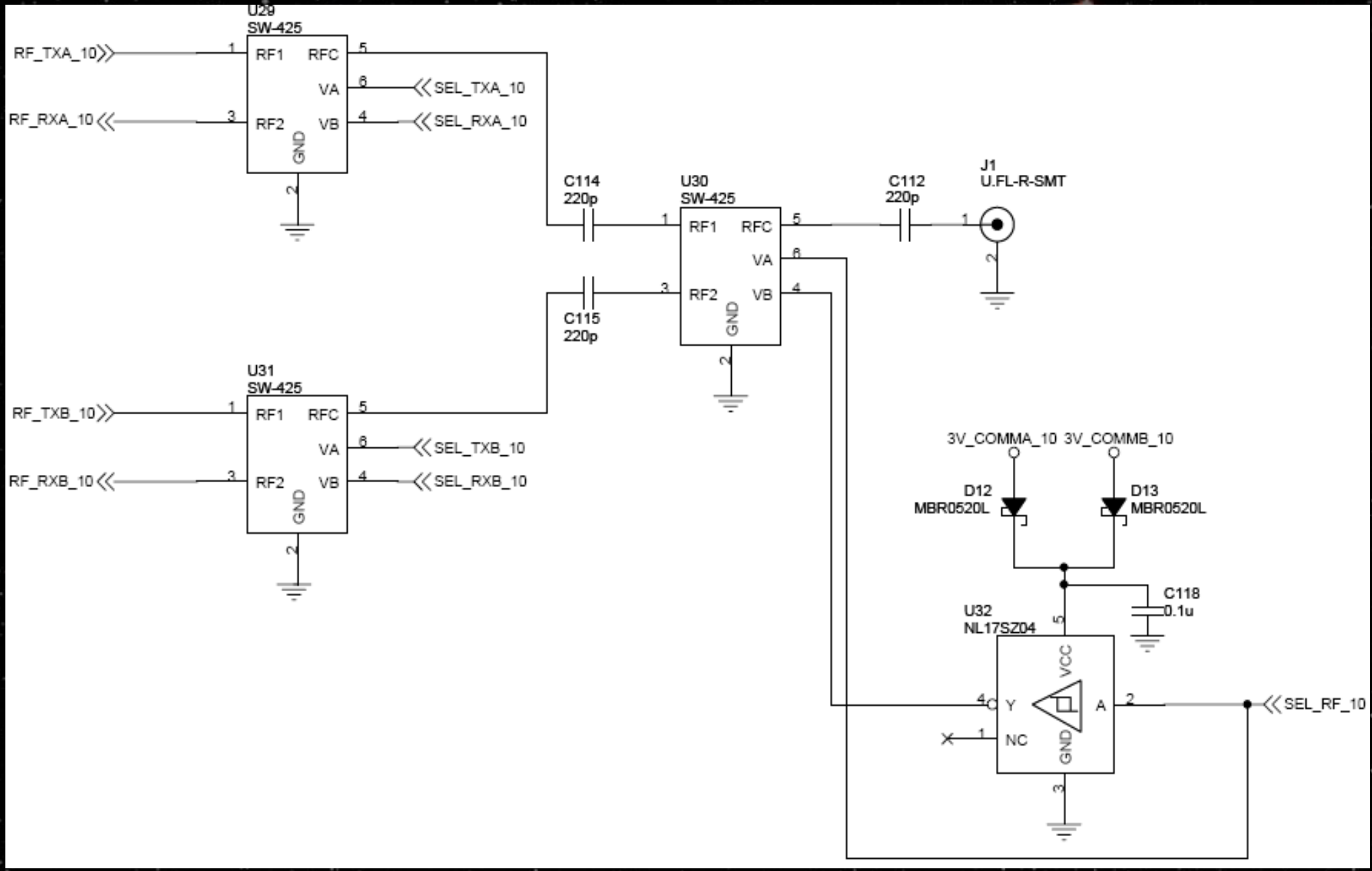


Satellite RF Amplifier

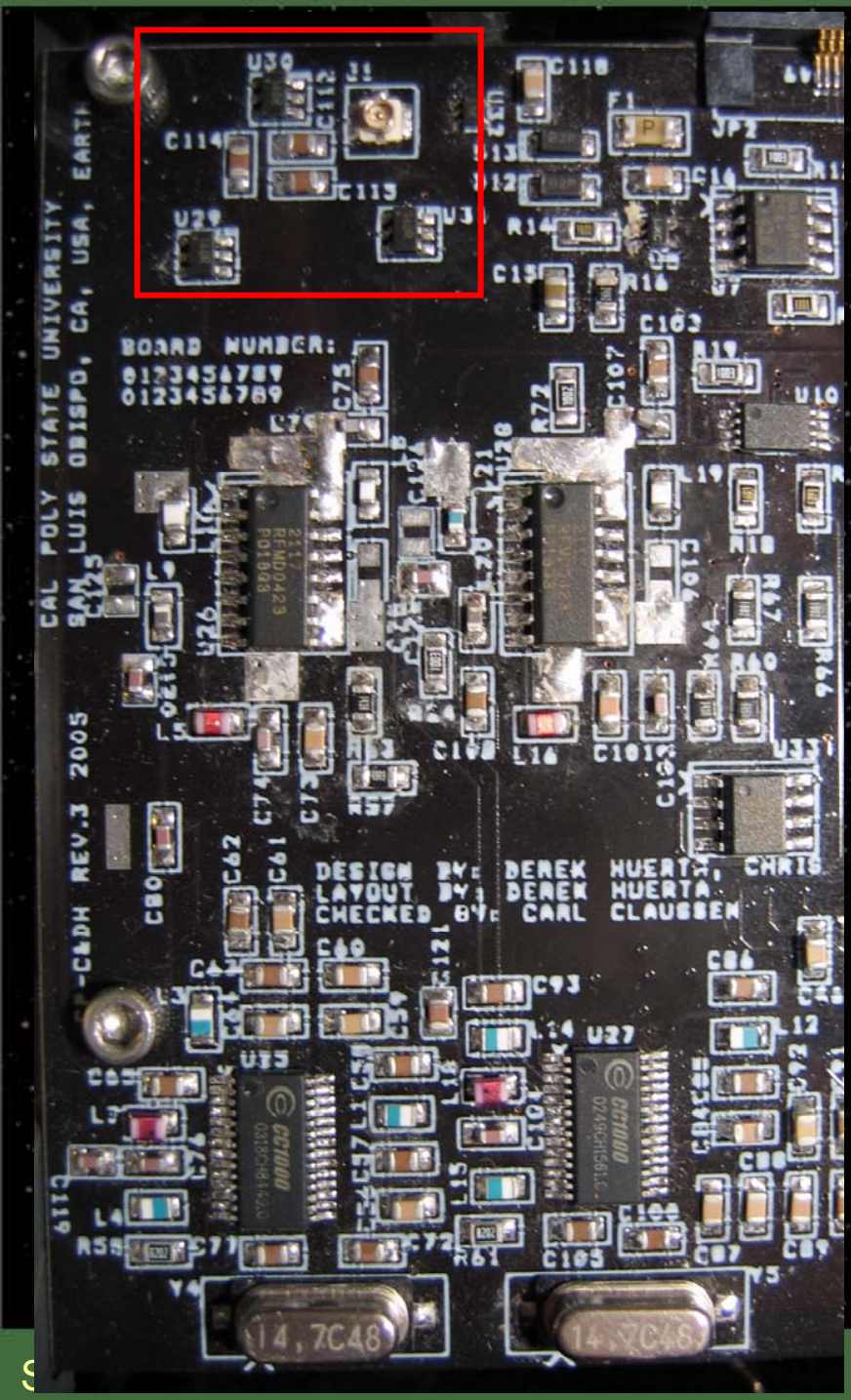


- RF2117
- 400 to 500 MHz
- +4 dBm input power
- +33 dBm output power
- 55% efficient

RF Switches

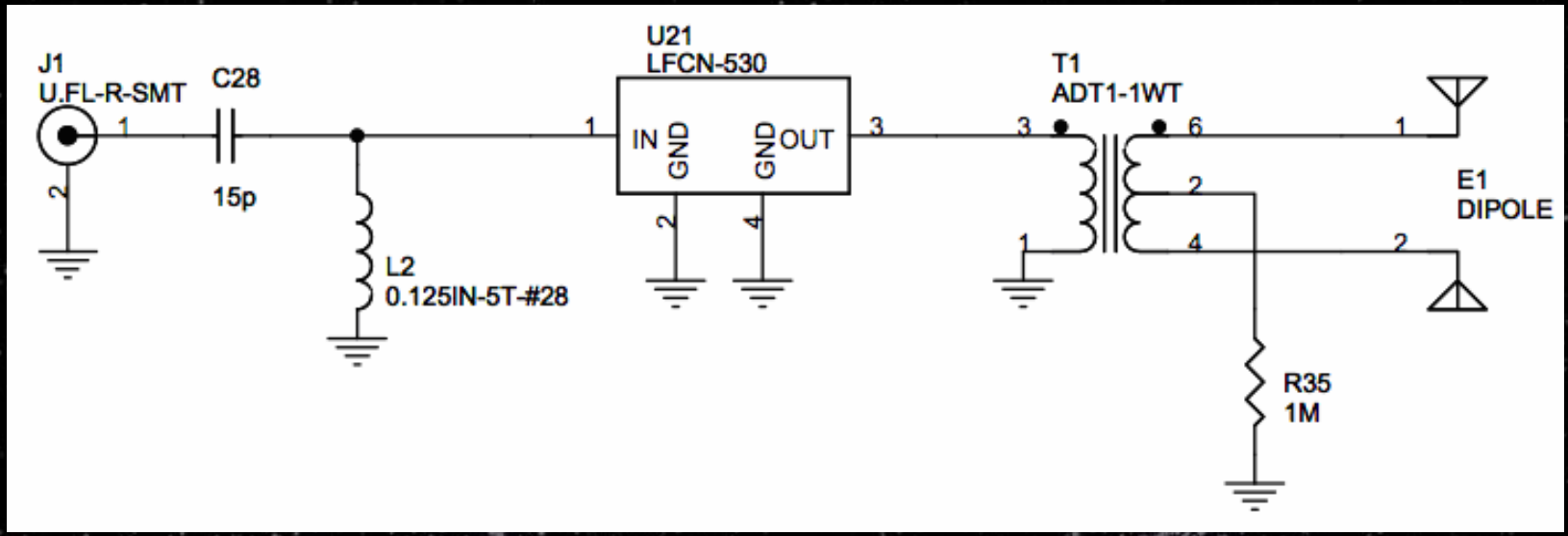

U29
SW-425
RF_TXA_10
RF_RXA_10
RF1
RF2
RFC
VA
VB
GND
SEL_TXA_10
SEL_RXA_10
C114
220p
C115
220p
U30
SW-425
C112
220p
J1
U.FL-R-SMT
U31
SW-425
RF_TXB_10
RF_RXB_10
SEL_TXB_10
SEL_RXB_10
3V_COMMA_10
3V_COMMB_10
D12
MBR0520L
D13
MBR0520L
C118
0.1u
U32
NL17SZ04
VCC
Y
A
NC
SEL_RF_10

RF Switches



- SW-425
- DC to 3 GHz
- Insertion loss 0.4 dB
- Max input power +36 dBm
- 3 switches:
  - Comm A and B
  - RX / TX

Antenna



- Low Pass Filter for harmonics
- Balun
  - Dipole antenna

We're Recruiting

- Are you interested in:
  - RF design
  - Microcontrollers
  - Low power design
  - DSP processors
  - Cameras / Imagers
  - PCB Layout and design
  - Earth Station satellite operations
  - Being awesome

- PolySat is recruiting motivated students to work on building next-generation satellites

- I have applications up front

Thanks

Questions?

polysat.calpoly.edu

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