Department of Computer Science
University of Massachusetts, Amherst

UMASSCS
DEPARTMENT OF COMPUTER SCIENCE

Moo 1.0 – A UMass Version Wireless Identification Sensing Platform

Hong Zhang
Lab of PRISMS, Department of Computer Science,
University of Massachusetts, Amherst

Contents

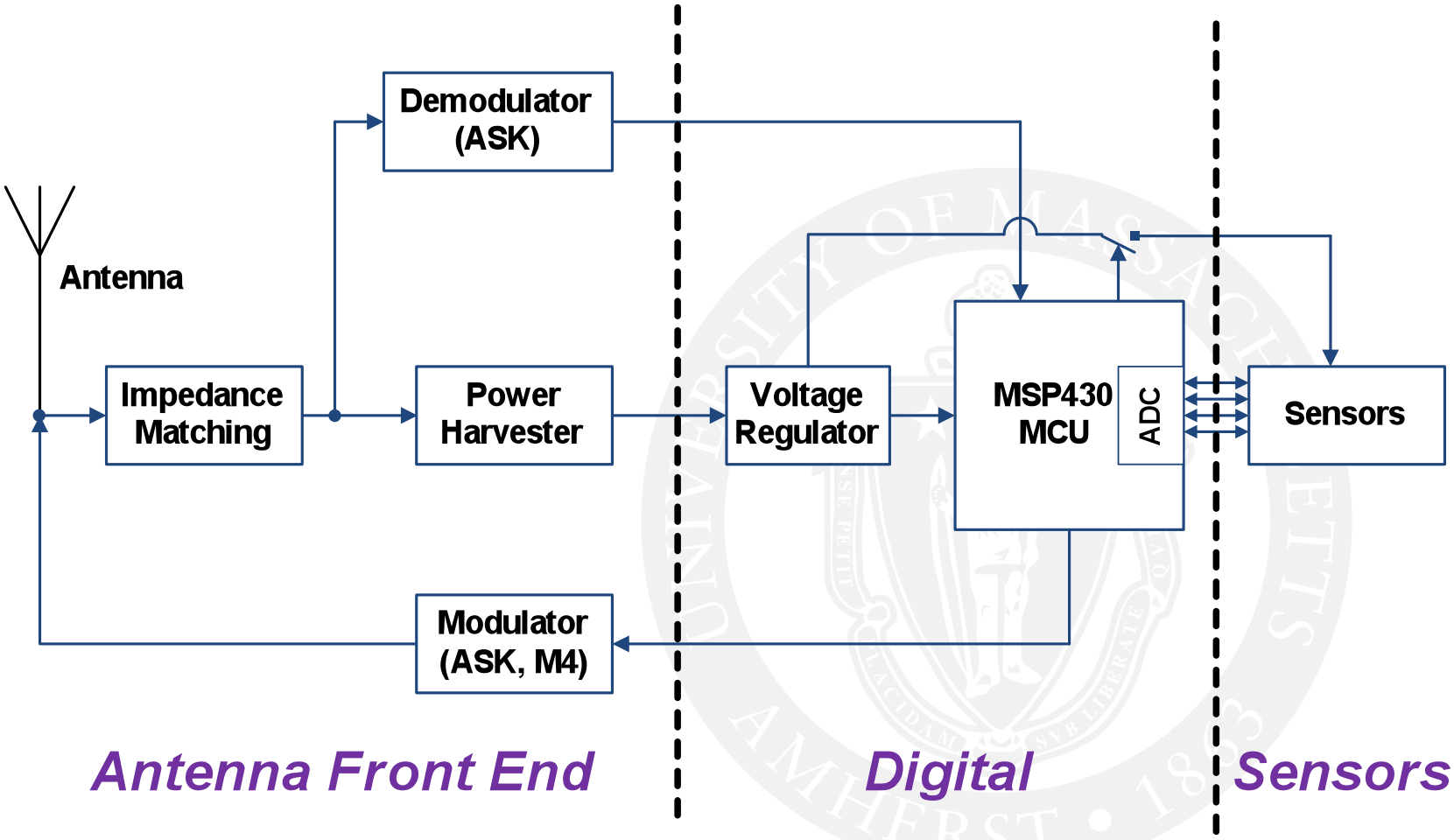
- 1. How does Moo 1.0 work?
- 2. What are Moo 1.0' kernels?
- 3. What will do in the future?

Contents

- 1. How does Moo 1.0 work?
- 2. What are Moo 1.0 kernels?
- 3. What can do in the future?

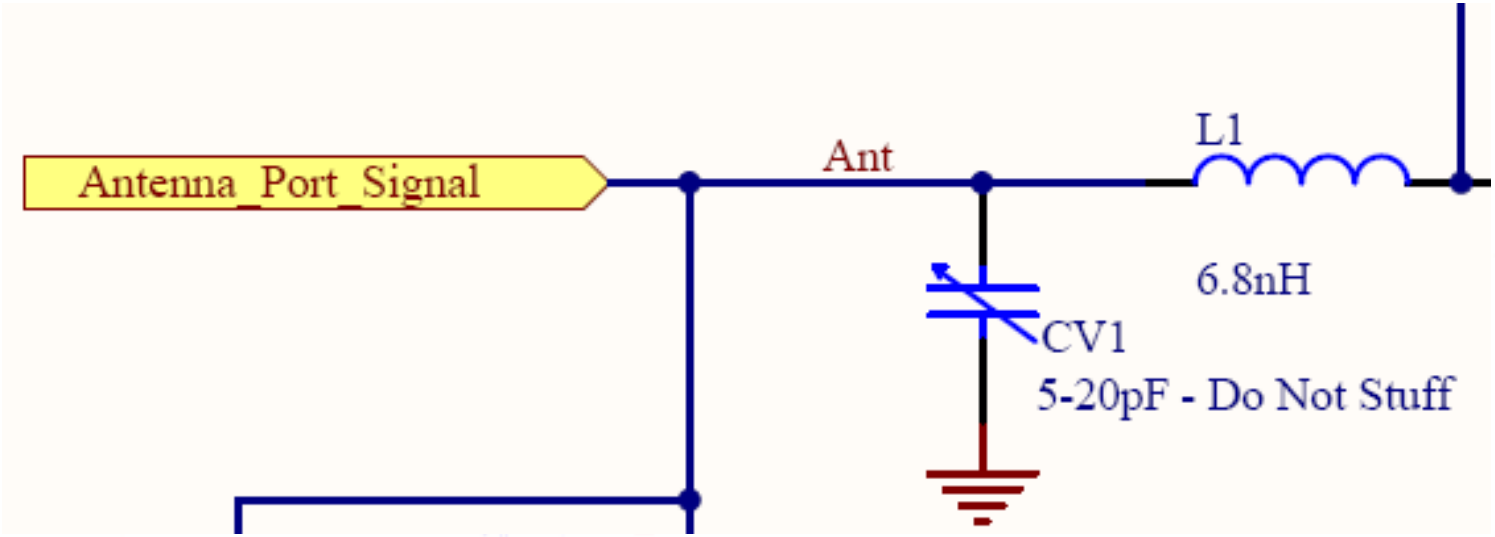
1. How does Moo 1.0 work?

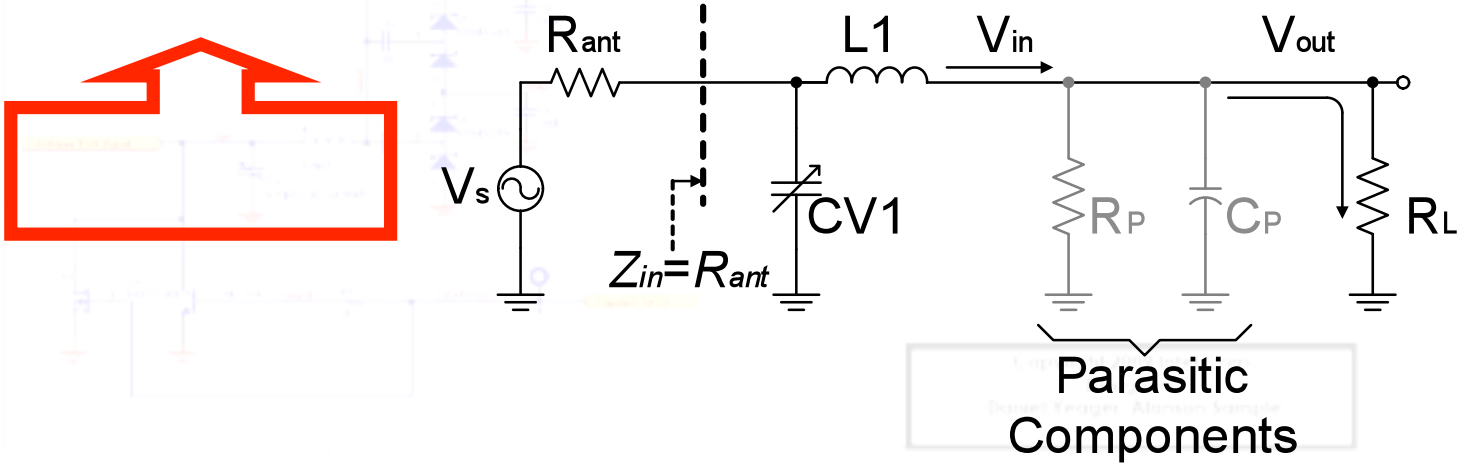
- **Block Diagram**



1. How does Moo 1.0 work?

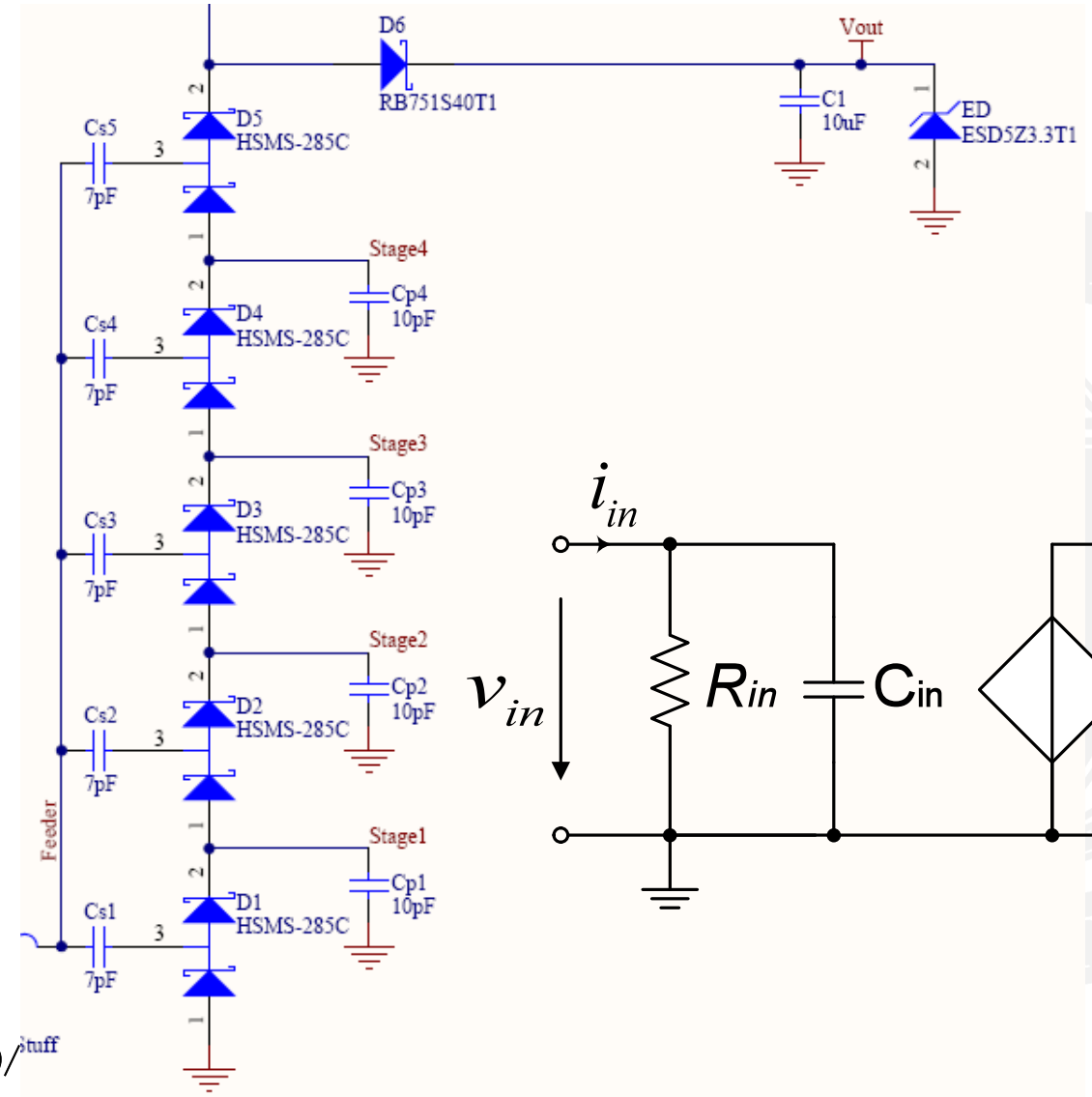
- **Impedance Matching**





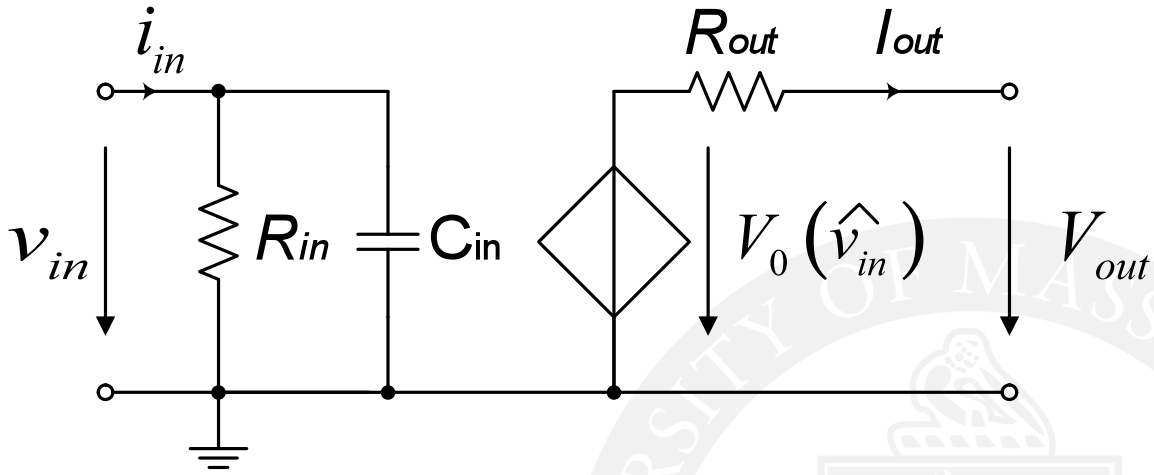
1. How does Moo 1.0 work?

- **Power Harvester**



1. How does Moo 1.0 work?

- **Power Harvester**



$$V_{out} = 2N\overline{V_D},\ N = 5,\ \overline{V_D} \le \hat{v}_{in}$$

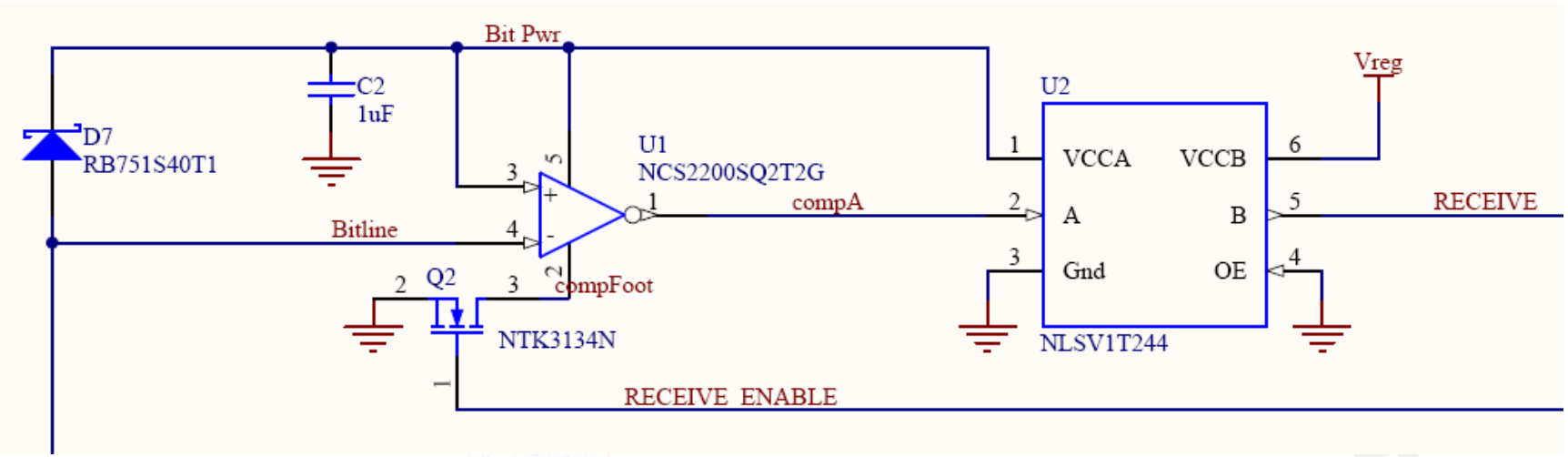
$$R_{in} = \frac{\hat{v}_{in}}{4NI_{out}},\ if\ \overline{V_D} = \hat{v}_{in}$$

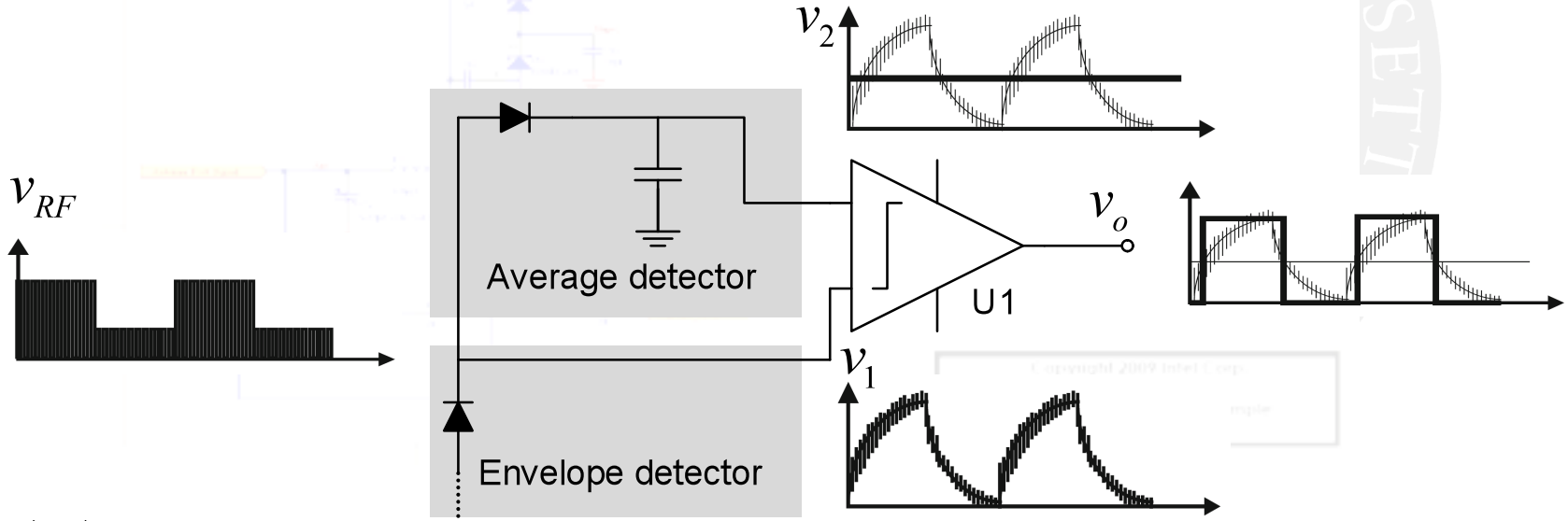
$$R_{out} = \frac{V_0 - V_{out}}{I_{out}},\ V_0 = 2N\overline{V_D}\Big|_{I_{out}=0}$$

$$C_{in} = C_{in,rectifier} + C_{added}$$

1. How does Moo 1.0 work?

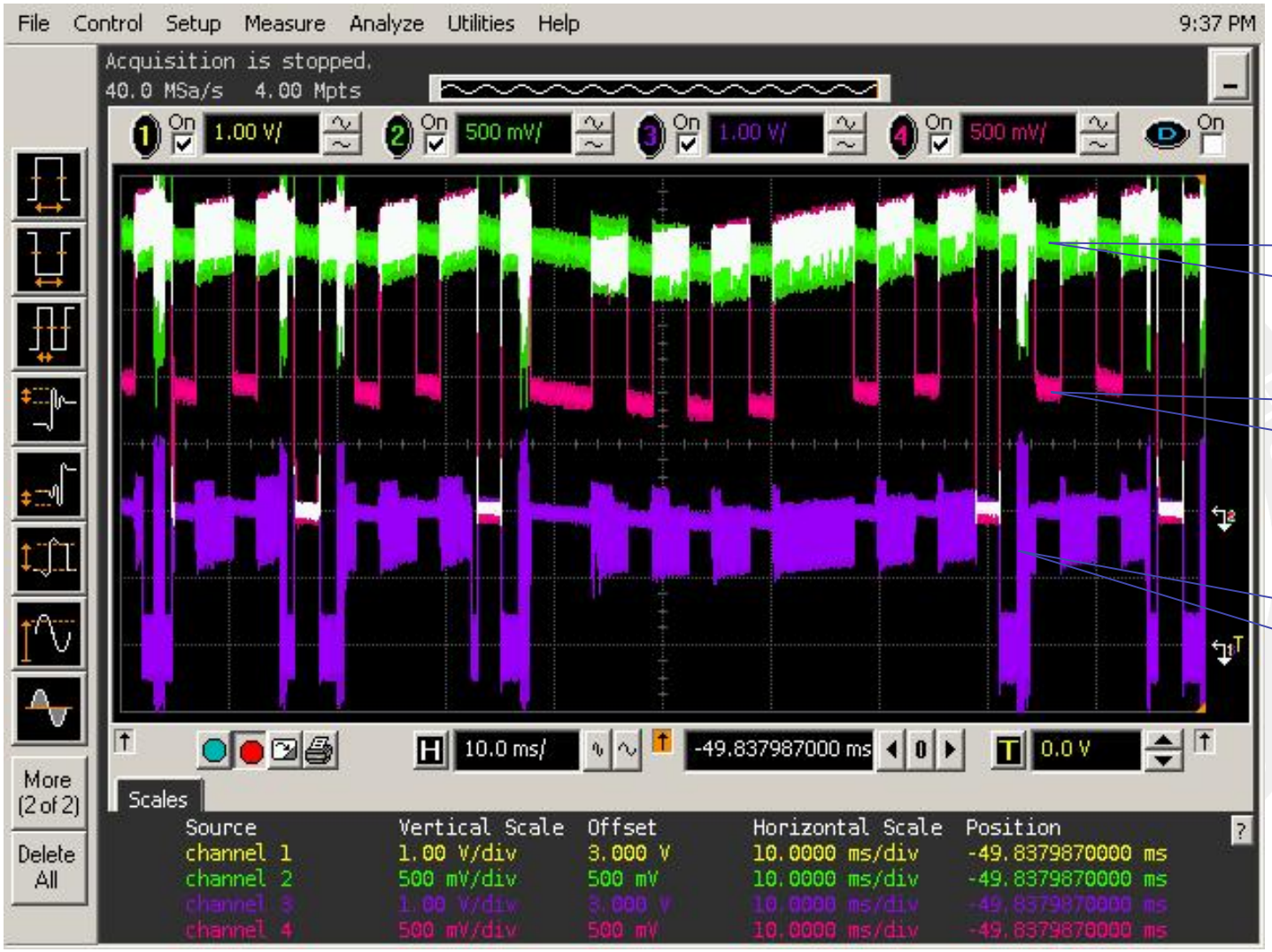
- **Demodulator (ASK – Amplitude-Shift Keying)**





1. How does Moo 1.0 work?

- **Demodulator (ASK – Amplitude-Shift Keying)**



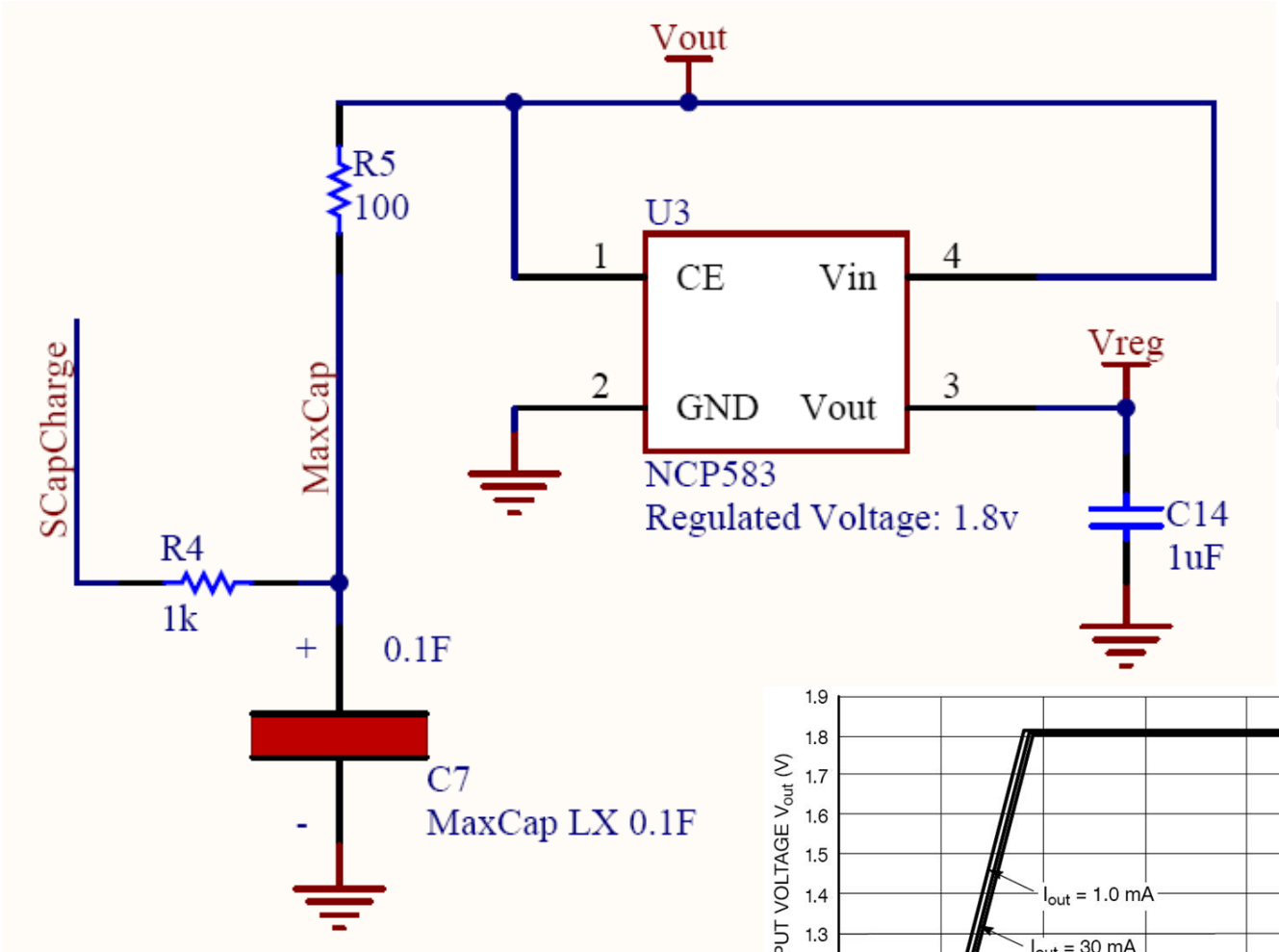
Green: Bit Power

Pink: Bit Line

Purple: CompA

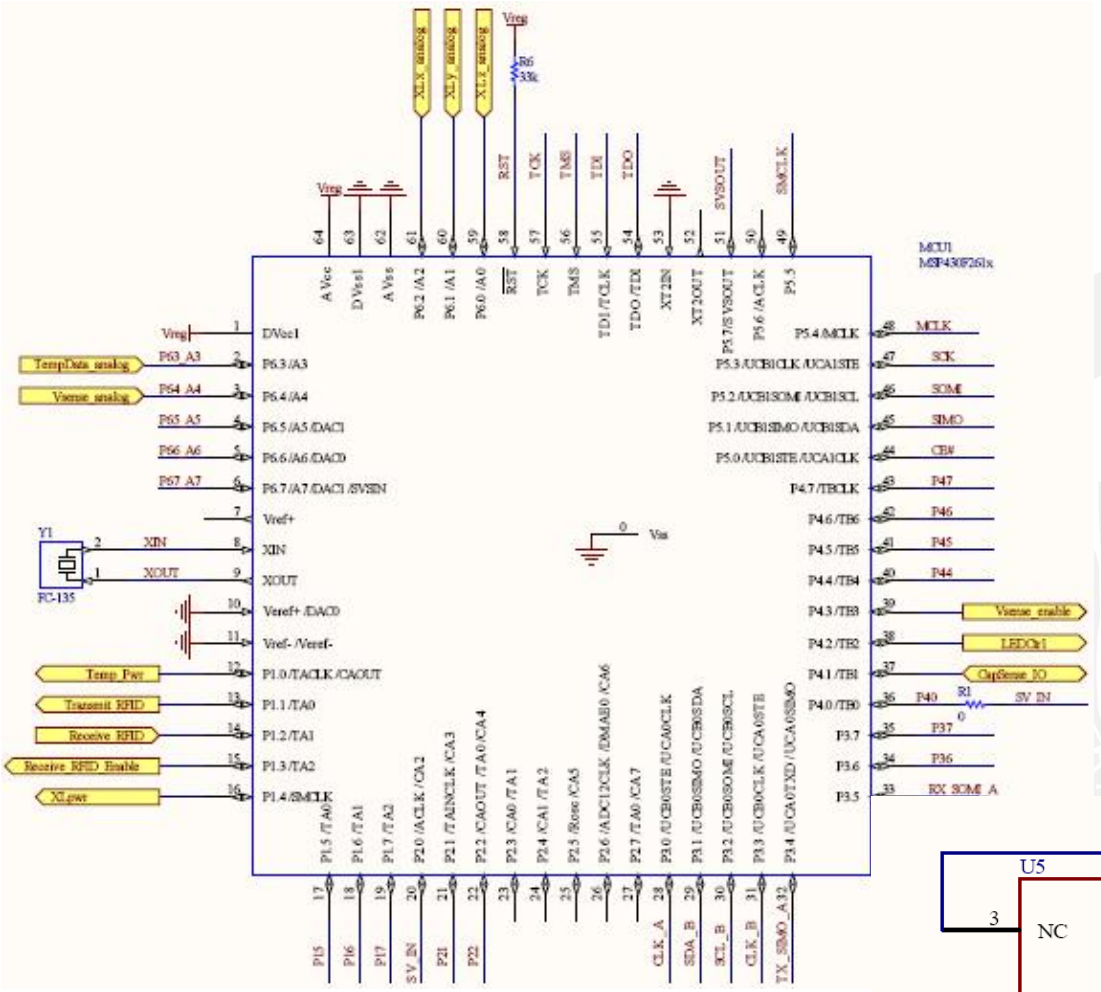
1. How does Moo 1.0 work?

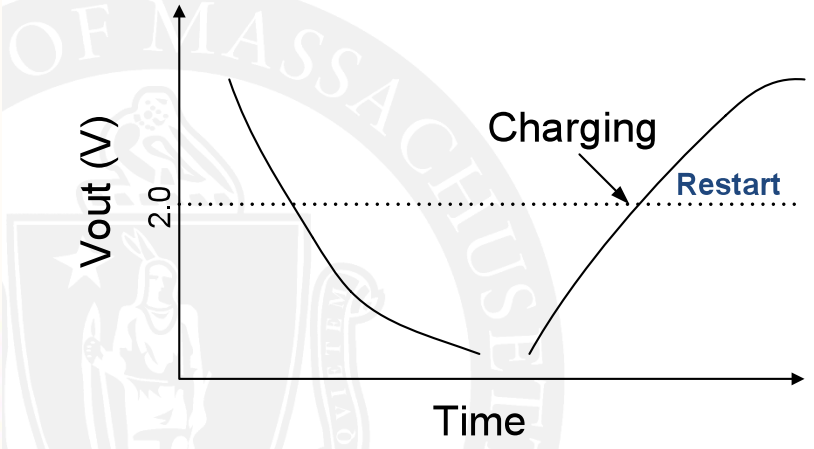
- **Voltage Regulator**

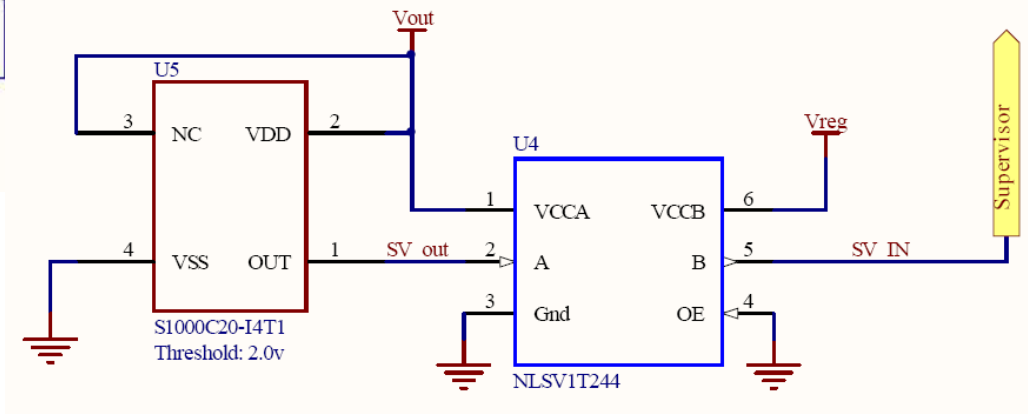


1. How does Moo 1.0 work?

- **MSP430 Micro-Controller**

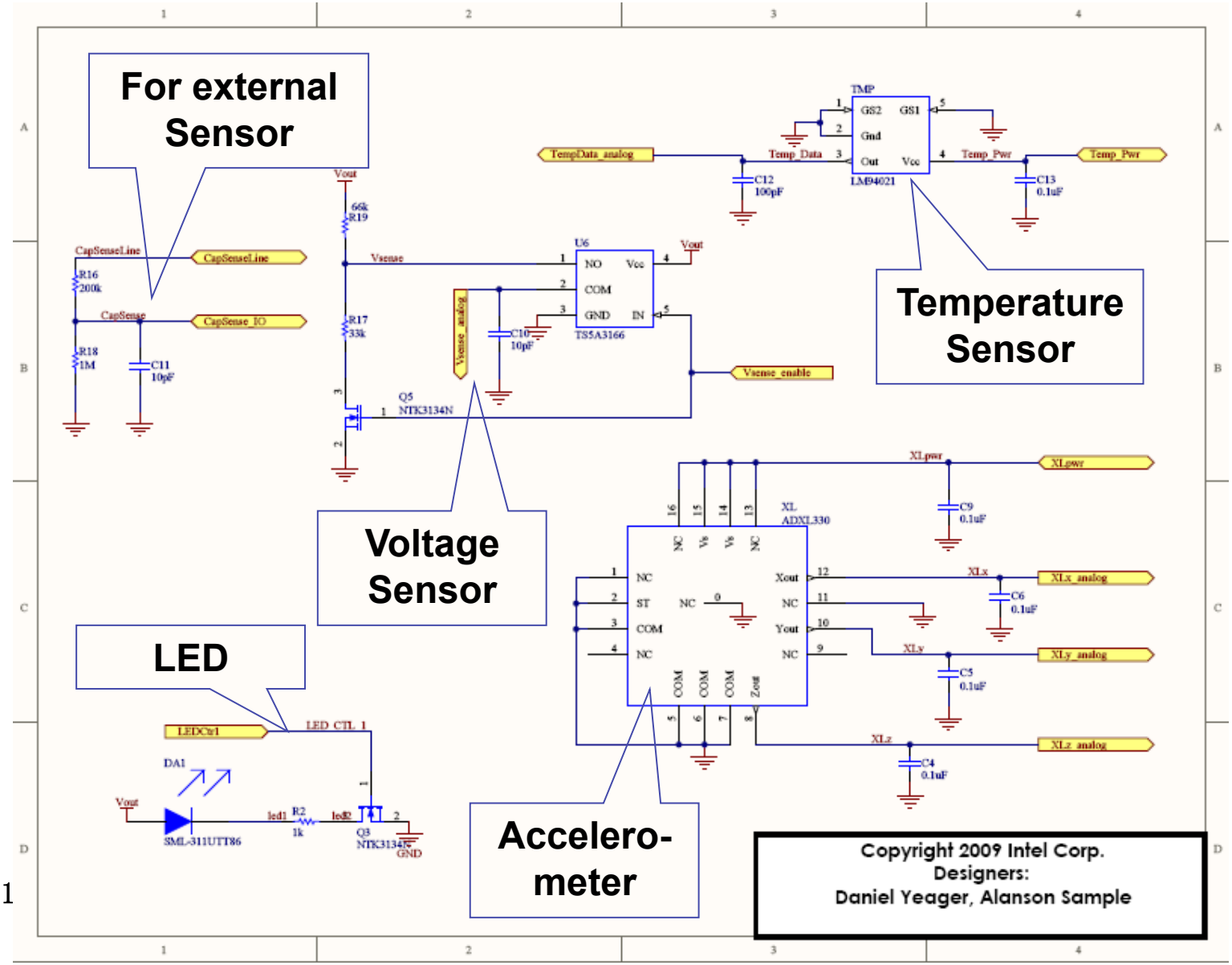






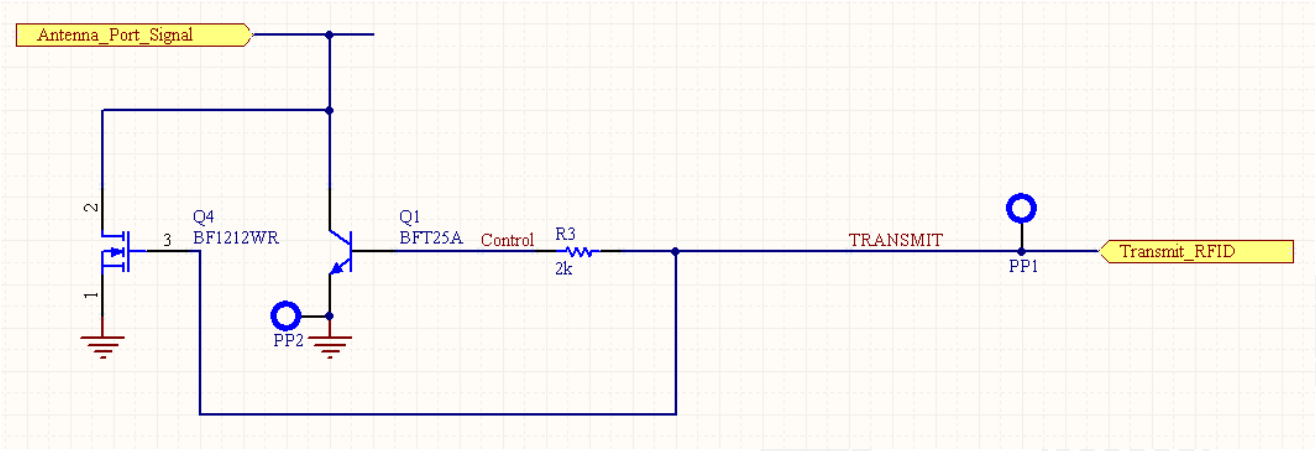
1. How does Moo 1.0 work?

- **Sensors**



1. How does Moo 1.0 work?

- **Modulator (ASK, M=4)**



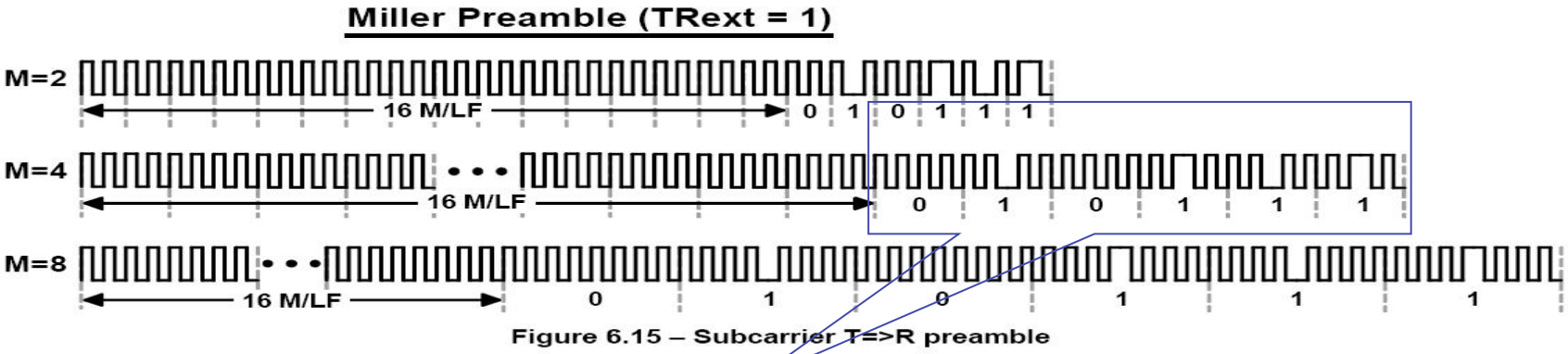
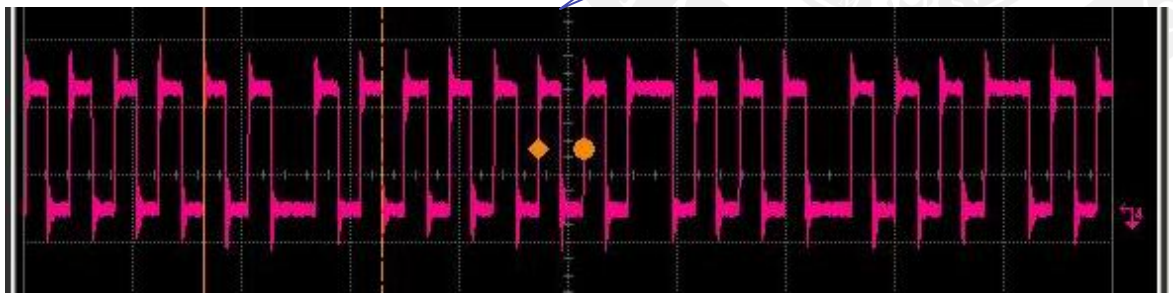


Figure 6.15 – Subcarrier T=>R preamble



Contents

- 1. How does Moo 1.0 work?
- 2. What are Moo 1.0 kernels?
- 3. What can do in the future?

2. What are Moo 1.0 kernels?

- **MCU: MSP430F2618**

MCU		MSP430F2618
Package		64-PIN QFP
Memory Size	**Flash**	**116KB+256B**
	RAM	**8KB**
Power Consumption	**Supply Voltage**	1.8V to 3.6V
	Active Mode	365uA@1MHz, 2.2V
	Standby Mode	**0.5uA**
	Off Mode	0.1uA
Architecture		16-Bit RISC Architecture 62.5ns Instruction Cycle Time 32-kHz Crystal 12-bit ADC/DAC
ADC	**Supply Voltage**	2.2V ~ 3.6V
	Supply Current	0.65mA@2.2V, 0.8mA@3V

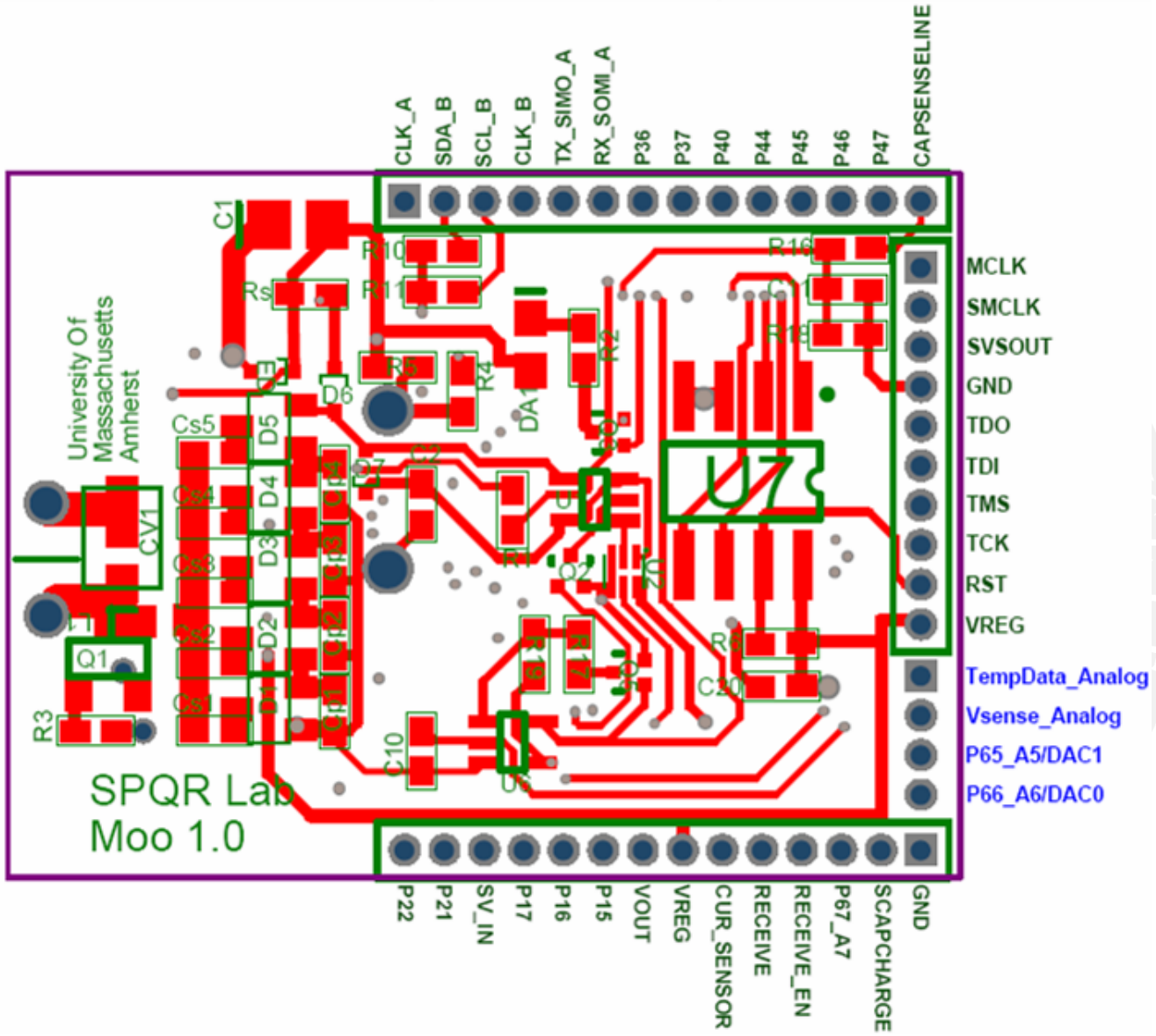
2. What are Moo 1.0 kernels?

❖ Memory: External Flash

Type #	**SST25WF040**
Description	On Moo 1.0
Memory Size	**4M (512K x 8)**
Speed	<= 20MHz
Supply Voltage	**1.65v ~ 1.95v**
Active Current	2mA @ 20MHz
Standby Current	2uA
Interface	SPI Compatible: Mode 0 and Mode 3
R/W/E time	Byte program (Byte Write): 50us Chip-erase: 125ms Block-erase: 62ms
Package	8-lead SOIC (150 mils)
Size	LxW = 5.80mm x 5.00mm

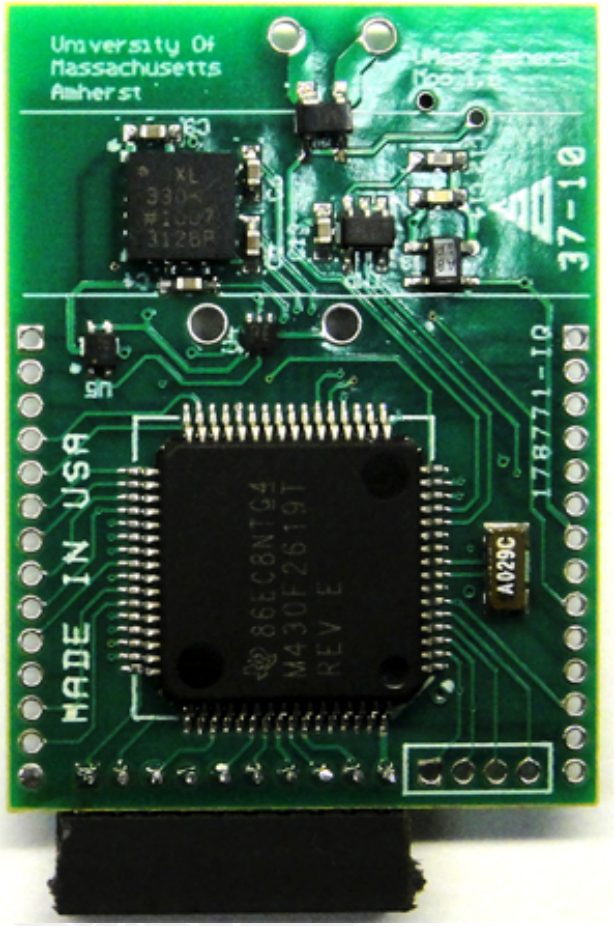
2. What are Moo 1.0 kernels?

- **42 I/O Ports: GPIOs. ADC/DAC. SPI buses**



2. What are Moo 1.0 kernels?

- **Size: Moo 1.0 vs a quarter dollar coin**



2. What are Moo 1.0 kernels?

- **Some estimation about power consumptions**
  - **When Moo 1.0 is about 1.3ft from RFID reader, the power harvester can harvest about (3V)^2/(12.65kOhm) = 0.7mW. The current is about 237uA.**
  - **When the 10uF capacitor is fully charged, it has a voltage of about 5.4V. Before the voltage of it drops to 3V, it can provide (5.4^2-3^2)/2*10^(-5) = 0.1mJ**
  - **When Moo 1.0 works actively and ADC is converting, the power consumed is about 3V*(365uA+0.8mA) = 3.5mW**
  - **With a full charged capacitor and harvesting from RFID reader at 1.3ft above, a rough estimation of continuous work time of Moo 1.0 is: 0.1mJ/(3.5mW-0.7mW)=35.7ms**
  - **Without harvesting, the work time is: 0.1mJ/3.5mW = 28.6ms**

Contents

- 1. How does Moo 1.0 work?
- 2. What does Moo 1.0 improve?
- 3. What can do in the future?

3. What can do in the future?

- **Antenna shape**
  - **Dipolar vs Meander**

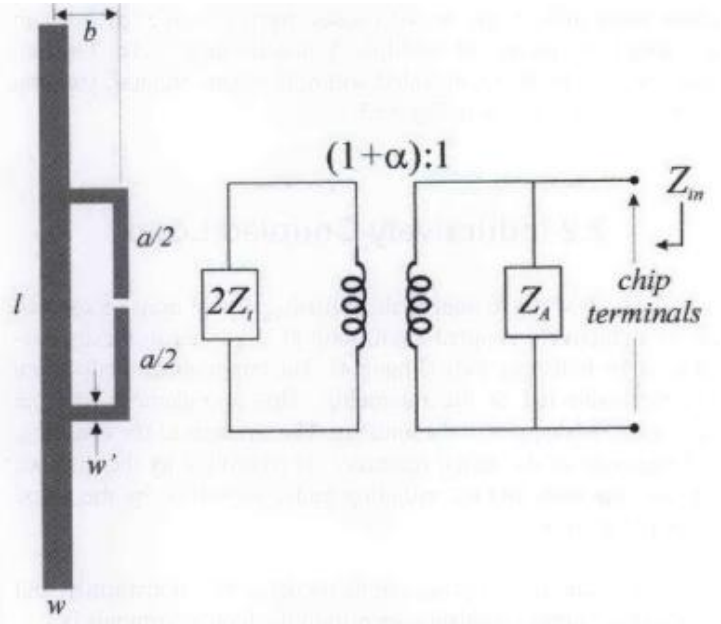


Figure 1. The T-match configuration for planar dipoles and the equivalent circuit, where the impedance step-up ratio $(1+\alpha)$ is related to the conductors' cross sections.

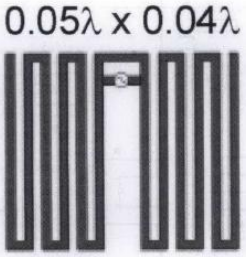


Figure 9a. An equi-spaced meander-line antenna.

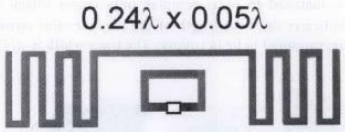


Figure 9b. A meander-line antenna with an inductively coupled loop feed.

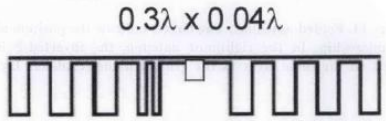


Figure 9c. An equi-spaced meander-line antenna with a loading bar.

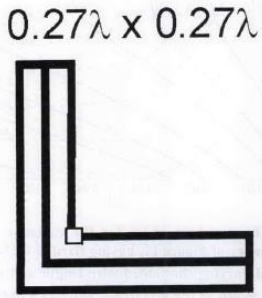


Figure 9d. A doubly-folded L-shaped dipole.

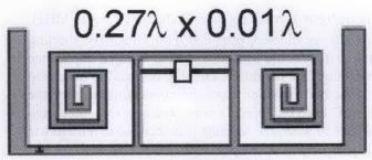


Figure 9e. A multiconductor antenna with a double T-match scheme and spiral folding.

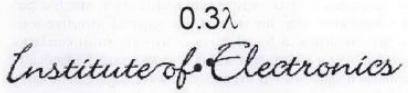


Figure 9f. A text-shaped meander-line antenna.

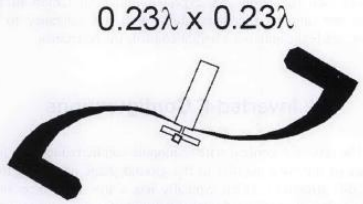


Figure 9g. A resonant tapered dipole that is partially meandered, with a resistive shorting stub and a double inductive stub.

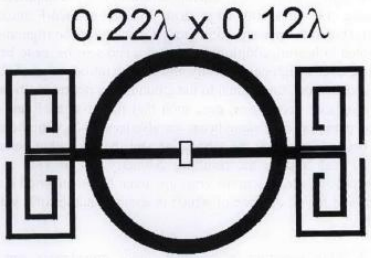
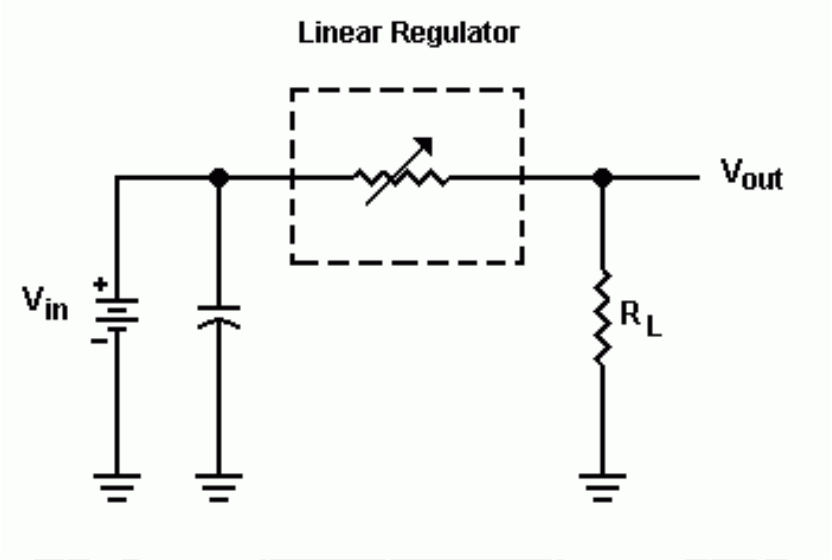
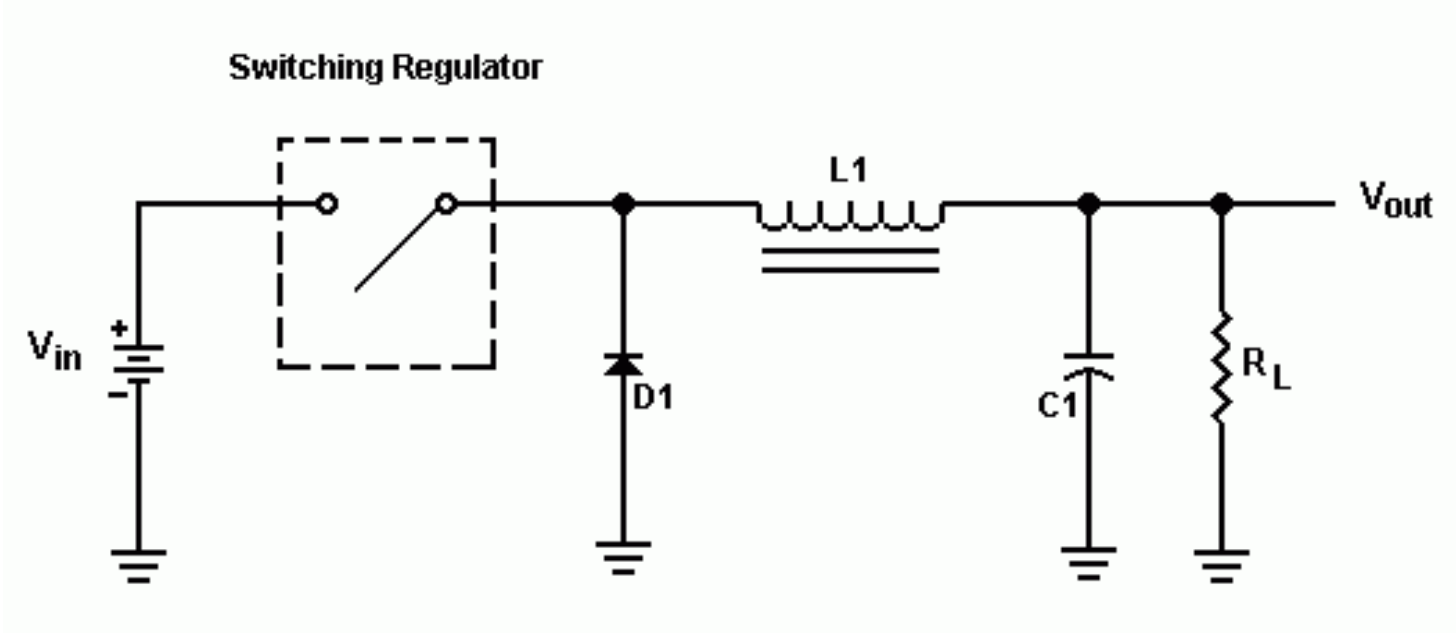


Figure 9h. A multiconductor meander-line tag with a circular-shaped double T-match.

3. What can do in the future?

- **Regulator**
  - **Linear vs Switch**





3. What can do in the future?

- **Adaptive firmware**
  - **Mementos**
  - **…**


Thanks!