Moo 1.0 – A UMass Version Wireless Identification Sensing Platform

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- 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

![Diagram of Antenna Front End and Digital Sensors]
1. How does Moo 1.0 work?

- Impedance Matching

![Diagram of Moo 1.0](image)

- Parasitic Components:
  - $V_s$ (Input Voltage)
  - $R_{ant}$ (Antenna Resistance)
  - $L_1$ (Inductance)
  - Parasitic Components: $R_p$ (Parasitic Resistance), $C_p$ (Parasitic Capacitance), $R_L$ (Load Resistance)
1. How does Moo 1.0 work?

- **Power Harvester**

![Diagram of Moo 1.0 Power Harvester](image)
1. How does Moo 1.0 work?

- **Power Harvester**

\[
\begin{align*}
V_{out} & = 2N\overline{V_D}, \quad N = 5, \quad \overline{V_D} \leq \hat{V}_{in} \\
R_{in} & = \frac{\hat{V}_{in}}{4NI_{out}}, \quad \text{if } \overline{V_D} = \hat{V}_{in} \\
R_{out} & = \frac{V_0 - V_{out}}{I_{out}}, \quad V_0 = 2N\overline{V_D}\bigg|_{I_{out}=0} \\
C_{in} & = C_{in,\text{rectifier}} + C_{\text{added}}
\end{align*}
\]
1. How does Moo 1.0 work?

- Demodulator (ASK – Amplitude-Shift Keying)
1. How does Moo 1.0 work?

- Demodulator (ASK – Amplitude-Shift Keying)

![Diagram showing the demodulator with green, pink, and purple lines indicating Bit Power, Bit Line, and CompA respectively.](image-url)
1. How does Moo 1.0 work?

- Voltage Regulator

![Circuit Diagram]

**NCP583**
Regulated Voltage: 1.8v

**Output Voltage V_out (V)**

- **V_out = 1.0 mA**
- **V_out = 30 mA**
- **V_out = 50 mA**
- **V_out = 2.8 V**

**Input Voltage V_in (V)**
1. How does Moo 1.0 work?

- MSP430 Micro-Controller
1. How does Moo 1.0 work?

- Sensors

For external Sensor

Temperature Sensor

Voltage Sensor

LED

Accelerometer

Copyright 2009 Intel Corp.
Designers:
Daniel Yeager, Alanson Sample
1. How does Moo 1.0 work?

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

![Diagram showing the modulator circuit](image)

**Miller Preamble (TRext = 1)**

- M=2
- M=4
- M=8

![Graph showing different preamble types](image)

*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**

<table>
<thead>
<tr>
<th></th>
<th>MCU</th>
<th>MSP430F2618</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Package</strong></td>
<td></td>
<td>64-PIN QFP</td>
</tr>
<tr>
<td><strong>Memory Size</strong></td>
<td>Flash</td>
<td>116KB+256B</td>
</tr>
<tr>
<td></td>
<td>RAM</td>
<td>8KB</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>Supply Voltage</td>
<td>1.8V to 3.6V</td>
</tr>
<tr>
<td></td>
<td>Active Mode</td>
<td>365μA@1MHz, 2.2V</td>
</tr>
<tr>
<td></td>
<td>Standby Mode</td>
<td>0.5μA</td>
</tr>
<tr>
<td></td>
<td>Off Mode</td>
<td>0.1μA</td>
</tr>
<tr>
<td><strong>Architecture</strong></td>
<td></td>
<td>16-Bit RISC架构</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62.5ns指令周期</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32-kHz晶振</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-bit ADC/DAC</td>
</tr>
<tr>
<td><strong>ADC</strong></td>
<td>Supply Voltage</td>
<td>2.2V ~ 3.6V</td>
</tr>
<tr>
<td></td>
<td>Supply Current</td>
<td><a href="mailto:0.65mA@2.2V">0.65mA@2.2V</a>, 0.8mA@3V</td>
</tr>
</tbody>
</table>
2. What are Moo 1.0 kernels?

- Memory: External Flash

<table>
<thead>
<tr>
<th>Type #</th>
<th>SST25WF040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>On Moo 1.0</td>
</tr>
<tr>
<td>Memory Size</td>
<td>4M (512K x 8)</td>
</tr>
<tr>
<td>Speed</td>
<td>&lt;= 20MHz</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>1.65v ~ 1.95v</td>
</tr>
<tr>
<td>Active Current</td>
<td>2mA @ 20MHz</td>
</tr>
<tr>
<td>Standby Current</td>
<td>2uA</td>
</tr>
<tr>
<td>Interface</td>
<td>SPI Compatible: Mode 0 and Mode 3</td>
</tr>
<tr>
<td>R/W/E time</td>
<td>Byte program (Byte Write): 50us</td>
</tr>
<tr>
<td></td>
<td>Chip-erase: 125ms</td>
</tr>
<tr>
<td></td>
<td>Block-erase: 62ms</td>
</tr>
<tr>
<td>Package</td>
<td>8-lead SOIC (150 mils)</td>
</tr>
<tr>
<td>Size</td>
<td>LxW = 5.80mm x 5.00mm</td>
</tr>
</tbody>
</table>
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 \((3V)^2/(12.65\text{kOhm}) = 0.7\text{mW}\). The current is about 237\text{uA}.

  - When the 10\text{uF} capacitor is fully charged, it has a voltage of about 5.4V. Before the voltage of it drops to 3V, it can provide \((5.4^2-3^2)/2*10^{-5} = 0.1\text{mJ}\)

  - When Moo 1.0 works actively and ADC is converting, the power consumed is about \(3V*(365\text{uA}+0.8\text{mA}) = 3.5\text{mW}\)

  - 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: \(0.1\text{mJ}/(3.5\text{mW}-0.7\text{mW})=35.7\text{ms}\)

  - Without harvesting, the work time is: \(0.1\text{mJ}/3.5\text{mW} = 28.6\text{ms}\)
Contents

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

- **Antenna shape**
  - Dipolar vs Meander
3. What can do in the future?

- **Linear vs Switch**

![Linear vs Switch Diagram](attachment:image.png)
3. What can do in the future?

❖ Adaptive firmware
  ▪ Mementos
  ▪ ...
  ▪ ...
Thanks!