Identification of Moisture Content in Cotton Bale by Microwave Imaging

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Abstract: Understanding of cotton quality is important in order to properly identify the moisture content .Measurement of moisture is difficult particularly at harvest and through the gin, because of the influence these processes have different fibre quality. Dry cotton can be harvested cleanly and efficiently but may suffer undue damage in the gin. On the other hand harvesting and ginning wet cotton leads to significant issues in processing and quality. A number of methods are used to measure moisture in seed cotton, lint and fuzzy seed, each has its varying advantages. A moisture variation of the bales that is not monitored from the outside of the bale. This research examines a new microwave imaging technique to view the internal moisture variations of cotton bale. Tests on the developed imaging sensor showed the ability to resolve small structures of parameters, against a low standard background, that were less than 1 cm in width. The accuracy of the sensing structure was also shown to provide the ability to accurately determine parameter standards. A preliminary test of the imaging capabilities on a wet commercial bale showed the technique was able to accurately image and determines the location of the wet layer within the bale.

Keywords: Bales, fibre, gigging, moisture, microwave imaging.

Introduction

In cotton grading the quality of cotton is identified by steple length, moisture level strength of cotton thread present all these parameter are identified manually, by the operator. In order to standardize this process the cotton project is intended. This project is focused on identification of moisture level in the cotton bale and generates appropriate result. The final stage in the cotton processing stream is the cotton bale packaging system. Recent innovations have shown

that the use of cotton moisture restoration systems both reduce stress on the bale packaging system as well as add additional weight to the bales. As cotton is sold on a wet basis, these systems were beginning to proliferate through the ginning industry. The research is needed because the excess moisture in the bales will cause fiber degradation and color-grade changes. This issue has become so important that it prompted the Cotton industry to make a recommendation for bales to be limited not to be less than 7.5% moisture.
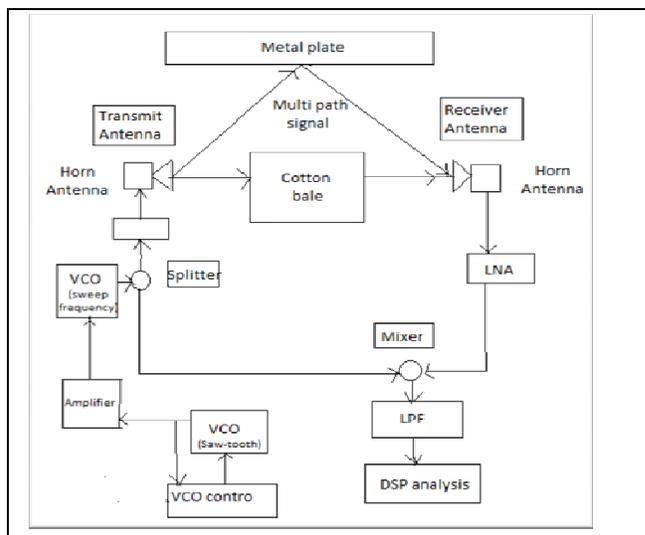

Fig.1 Schematic layout of detection of moisture

Approaches in measuring moisture

The methods for measuring moisture in cotton lint can be classified into six groups based on the technique and on the type of cotton material being tested, such as compacted or loose seed cotton, loose lint moved by air in ducting or compressed baled lint. Moisture measurement methods can be based on:

1. Thermal drying.
2. Chemical.
3. Spectroscopy.
4. Measurement of electrical or dielectric properties.
5. Compression properties of cotton lint.

What is Microwave imaging method?

This method involving the transmission of microwaves (electromagnetic radiation) signal of range between 2400-2480 MHz, content in cotton bale using microwave method. Signal through the bale to determine change of signal in order to penetrate this signal through a cotton bale without interrupting of signal to detect the change in phase and signal strength at receiver end.

What is the Role of CC2500 module?

C2500 is a Low-Cost Low-Power RF Transceiver. It functions in 2400- 2483.5 MHz frequency band and provides an excellent option for WSN applications because of its low-power characteristics and SRD (Short Range Device) frequency band

This chip has 20 pins as,

* 2 for connecting a (mandatory) 26MHz external Crystal oscillator.
* 2 for connecting the antenna.
* 10 for powering the chip.
* 6 for digital communication with the Microcontroller.
* The chip contains 47 registers to configure operating frequency, modulation scheme, baud rate, transmission power, etc. Because these registers are erased during power down, the MSP430 should configure all of them at startup.
* 13 commands allow the Microcontroller to control the state of the CC2500 (transmit, power Down, receive, etc).

The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate of up to 500 k Baud. CC2500 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear

in No.	Name of Pin	Pin No.	Name of Pin
1.	SCLK Digital Input	11.	AVDD Power (Analog)
2.	SO (GDO1) Digital Output	12.	RF_P RF I/O
3.	GDO2 Digital Output	13.	RF N RF I/O
4.	DVDD Power (Digital)	14.	AVDD Power (Analog)
5.	DCOUPL Power (Digital)	15.	AVDD Power (Analog)
6.	GDO0 (ATEST) Digital I/O	16.	GND Ground (Analog)
7.	CSn Digital Input	17.	RBIAS Analog I/O
8.	XOSC_Q1 Analog I/O	18.	DGUARD Power (Digital)
9.	AVDD Power (Analog)	19.	GND Ground (Digital)
10	XOSC_Q2 Analog I/O	20.	SI Digital Input

Fig Pin Configuration of CC2500

channel assessment, link quality indication, and wake-on-radio. The main operating parameters and the 64- byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In a typical system, the CC2500 will be used together with a microcontroller and a few additional passive components.
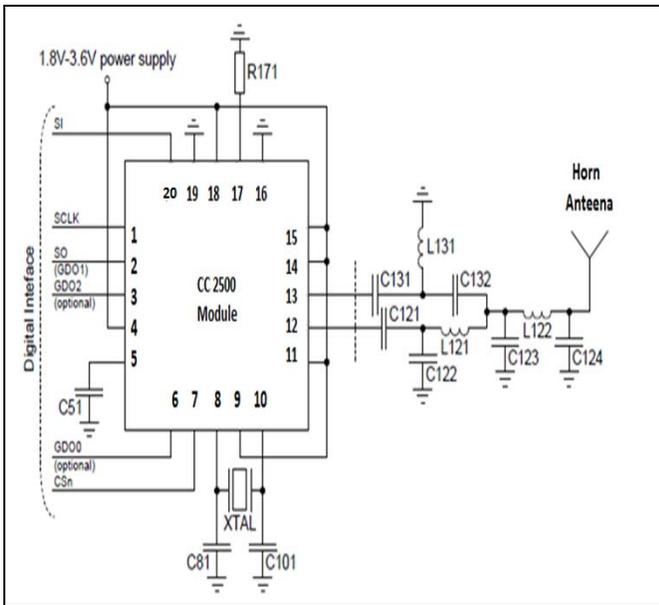
Fig2. Pin diagram of CC2500 module.

What is the role of MSP430 Microcontroller?

MSP430 is a great fit for any mobile application, where power conservation is a priority. The many power-saving mechanisms designed into the MSP430 make it ideal for such applications. An emerging application is ISM-band (Industrial, Scientific, and Medical) and SRD-band (Short Range Device) wireless connections, in the 315/433/868/915-MHz and 2.4-GHz bands. Markets served by this application include AMR (Automatic Meter Reading), low-power telemetry, and wireless sensor networks. It supports RF link with CC2500 forms a highly power-efficient wireless node that can transceive data at rates up to 500 kbps. The CC2500 is equipped with a SPI port, through which they can communicate with an MSP430
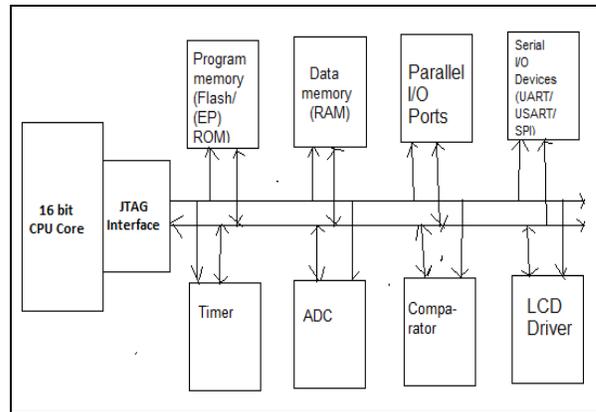

Fig. Block diagram of MSP 430 uC

The Texas Instruments (TI) MSP430 family of processors are low power 16 bit devices. They are marketed at low power applications such as battery devices, however in spite of this they contain a sophisticated processor core and depending upon the model, a useful array of integrated peripherals. It produces a set of microcontrollers based around a core 16 bit CPU as shown in Figure above.

Some features of msp430:
- Ultra-low-power 16-bit RISC mixed-signal processors.
- Low power & high performance Seven source-addressing modes.
- Four destination-address modes.
- Only 27 core instructions.
- Prioritized, nested interrupts.
- No interrupt or subroutine level limits.
- Large register file.
- Ram execution capability.
- Efficient table processing.
- Fast hex-to-decimal conversion

What is SPI-Interface?

Most of the communication between the controller and the CC2500 is done using industry standard SPI (Serial Peripheral Interface) locks that work reliably with CC2500. However, the SPI-interface of the CC2500 requires a chip select -signal which must be generated on software. In addition to the SPI-interface, the CC2500 also provides two extra signals GD0 and

GD2. Function of these signals can be selected rather freely (see datasheets of the CC2500 for details). In the most basic design these signals are used to signal the Controller when a valid packet has been received and transmit is complete. In this design, handling these signals is done completely using software. Among other options, these signals can also be used to transmit and receive asynchronous data up to 250 kbps.

SPI is implemented in the MCU by a hardware module called the Synchronous Serial Port or the Master Synchronous Serial Port SPI is a Data Exchange protocol. As data is being clocked out, new data is also being clocked in.

When one "transmits" data, the incoming data must be read before attempting to transmit again. If the incoming data is not read, then the data will be lost and the SPI module may become disabled as a result. Always read the data after a transfer has taken place, even if the data has no use in your application.

Data is always "exchanged" between devices. No device can just be a "transmitter" or just a "receiver" in SPI. However, each device has two data lines, one for input and one for output.

These data exchanges are controlled by the clock line, SCK, which is controlled by the master device.

RF Performance
- High sensitivity (–104 dBm at 2.4 kBaud, 1% packet error rate).
- Low current consumption (13.3 mA in RX, 250 kBaud, input well above sensitivity limit).
- Programmable output power up to +1 dBm.
- Excellent receiver selectivity and blocking performance.
- Programmable data rate from 1.2 to 500 kBaud.
- Frequency range: 2400 – 2483.5 MHz

Analog Features
- OOK, 2-FSK, GFSK, and MSK supported.
- Suitable for frequency hopping and multichannel systems due to a fast settling frequency synthesizer with 90 us settling time.
- Automatic Frequency Compensation (AFC) can be used to align the frequency synthesizer to the received centre frequency.
- Integrated analog temperature sensor.

Digital Features

- Flexible support for packet oriented systems: On-chip support for sync word detection, address check, flexible packet length, and automatic CRC handling.
- Efficient SPI interface: All registers can be programmed with one "burst" transfer.
- Digital RSSI output Programmable channel filter bandwidth.
- Programmable Carrier Sense (CS) Indicator.
- Programmable Preamble Quality Indicator (PQI) for improved protection against false sync word detection in random noise.
- Support for automatic Clear Channel Assessment (CCA) before transmitting (for listen-before-talk systems).
- Support for per-package Link Quality Indication (LQI).
- Optional automatic whitening and de-whitening of data.

Low-Power Features
- 400 nA SLEEP mode current consumption
- Fast startup time: 240 us from SLEEP to RX or TX mode (measured on EM design)
- Wake-on-radio functionality for automatic low-power RX polling
- Separate 64-byte RX and TX data FIFOs (enables burst mode data transmission)

General
- Few external components: Complete on chip.
- Frequency synthesizer, no external filters or RF switch needed.
- Green package: RoHS compliant and no antimony or bromine
- Small size (4x4 mm package, 20 pins)
- Support for asynchronous and synchronous serial receive/transmit mode for backwards compatibility with existing radio communication protocols.

Conclusion

The design and implementation of this project is helping the cotton industry to design a particular criterion to purchase the moisture free cotton from the market and accordingly increasing the quality, accuracy and precision of the cotton for further processing.

The use of microwave imaging is becoming more

prevalent for detection of interior hidden defects in manufactured and packaged materials. In applications for detection of hidden moisture, microwave imaging technology can be used to image a bale and then perform an inverse calculation to derive an estimate of the variability of the hidden interior moisture, thereby alerting personnel to damaging levels of unseen moisture before fibre degradation occurs.

The use of sensors is very costly and sensor based technic is with the packaging utilizes metal strapping ties, as the metal bale ties combine to create significant Mie scattering that causes destructive and constructive interference as the material is conveyed past the imaging antenna array, where the use of cc2500 module is that work on radio frequency act as a trans receiver and gives precise and accurate response.

In the previous technics used the different manually operated chemical methods are used so it makes it complicated from the efficiency point of view. The previous methods are some where dependent methods of operations which will make the process poor in detections of moisture in the bale. The measurement of moisture via microwave transmission through modules and bales stands as a relatively accurate and robust method. Accurate, in-line methods for measuring the moisture of material during harvesting and particularly ginning will become increasingly important as energy costs and fibre quality premiums rise.

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