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Wireless Electric Power Quality Sensor

Group D10

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Abstract

The report discuss the approaches of making a system(whcih is using MSP) wireless enable. It will specifically discuss power quality sensor which measure and process the current and voltage of main electric line. The voltage and current value of electric line is used to measure the power quality and other parameters. It is required to send all the calculated parameters to a central hub where it can take decision on load distribution etc. The power quality sensor system transmits the data wirelessly using CC1000. We attempted to interface CC1000 with MSP430F168 using SPI, UART and general I/O pin of microcontroller.

1 Problem Statement:

To make the given power quality sensor board wireless enable using CC1000 plug and play module

2 Introduction:

In industrial usage wired connection between different power quality sensor and central hub is impractical. It is necessary to send the data wirelessly. The power quality sensor is integrated with CC1000 to send the calculated parameter wirelessly. CC1000 module is a UHF transceiver designed for very low power and very low voltage wireless applications. The main operating parameters of CC1000 can be programmed via a serial bus, thus making CC1000 a very flexible and easy to use transceiver.

The wireless power quality system comprises of three stages:

1) **Power quality measurement**: The 230V line and current sensor are used to fed the value of voltage and current of main line respectively. The signals are properly scaled and conditioned before sending it to the MSP430 analog lines. The analog signals are converted to digital data using ADC of MSP430.

2) **Microcontroller and CC1000 interface:** The wireless communication parameters of CC1000 are configured by MSP430 (same microcontroller that is used for power quality measurement sensor). 3 general Input/output lines are used to program the 28 registers of CC1000. Bit banging is used to configure CC1000. UART is used for data transmission between MSP and CC1000.

3) **Data reception and storing the data on PC:** The receiver module of CC1000 is configured by MSP430. The received data are stored in MSP430 and then transmitted to PC through USB interface.

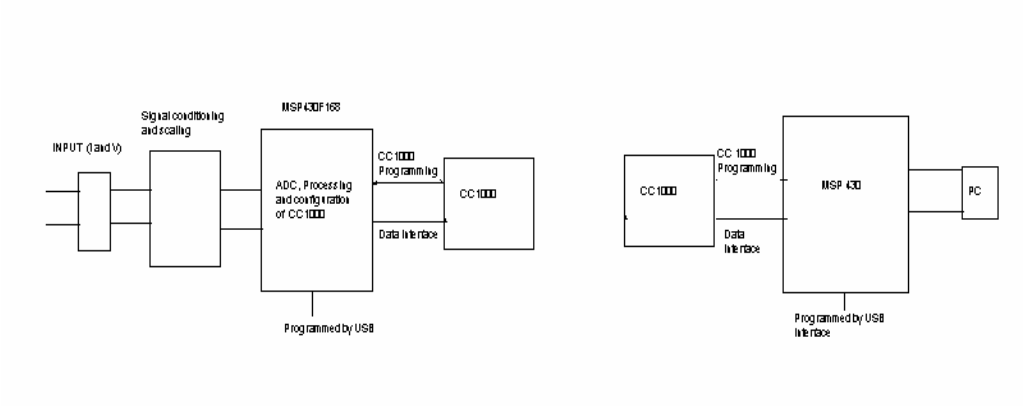

Figure 1:Block diagram representaion of system

3 Design of System:

Hardware

1) The two input plugs for measurement of current and voltage from the main line is used. The values of current and voltage are scaled to fed into analog lines of MSP430. The scaling and conditoning part is performed by Opamp circuit. The scaled version is converted to digital by ADC of MSP. The MSP is programmed through USB interface. The serial to USB converter TUSB is used. The MSP is powered through USB pin. The Port 3 of MSP430 is used to interface it with CC1000 PP module. CC1000 is integrated on the given power quality sensor board. The schematic of power quality sensor and CC1000 plug and play module is attached.

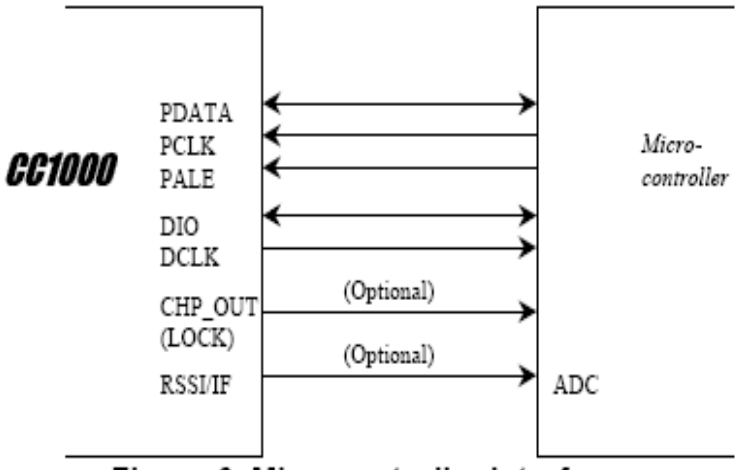

Figure 2: The pin connection between MCU and CC1000

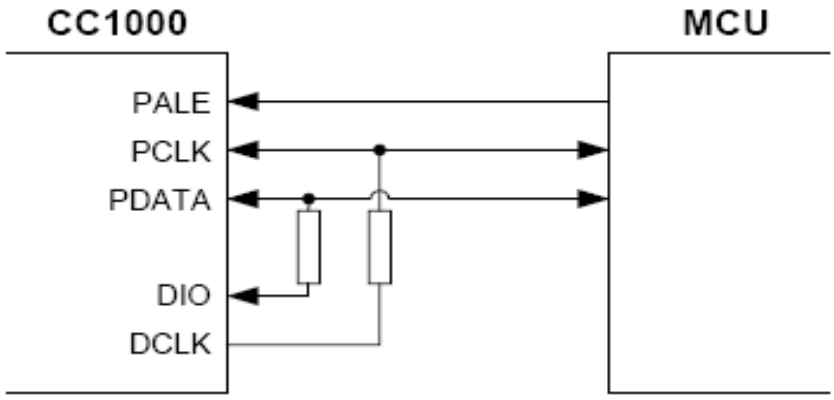

Figure 3: The hardware connection between MCU and CC1000

CC1000	MSP430 Port3	Pin
PALE	P3.0	28
PCLK	P3.3	31
PDATA	P3.1	29
DI/O	P3.1 (Through Resistor)	29
DCLK	P3.3 (Through Resisitor)	31

Software

The MSP430 bootstrap loader (BSL) is used to communicate with embedded memory in the MSP430 microcontroller during the prototyping phase. The commonly used UART protocol with RS232 interfacing with MSP430 is used. The serial to USB converter is used to finally interface MSP with PC.

The microcontroller is used to configure the CC1000 and for bi-directional data transfer. CC1000 configuration: There are 28 8-bit configuration registers, each addressed by a 7-bit address. CC1000 is programmed into different modes via the 3-wire serial

configuration interface (PDATA, PCLK and PALE). Bit banging is used for programming CC1000. The value of registers of CC1000 is calculated by SmartRF studio and datasheet of CC1000.
Through the programmable configuration registers the following key parameters are programmed:

- Receive / transmit mode
- RF output power
- Frequency synthesizer key parameters: RF output frequency, FSK fequency separation (deviation), crystal oscillator reference frequency.
- Power-down / power-up mode
- Crystal oscillator power-up / power down
- Data rate and data format (NRZ, Manchester coded or UART interface)

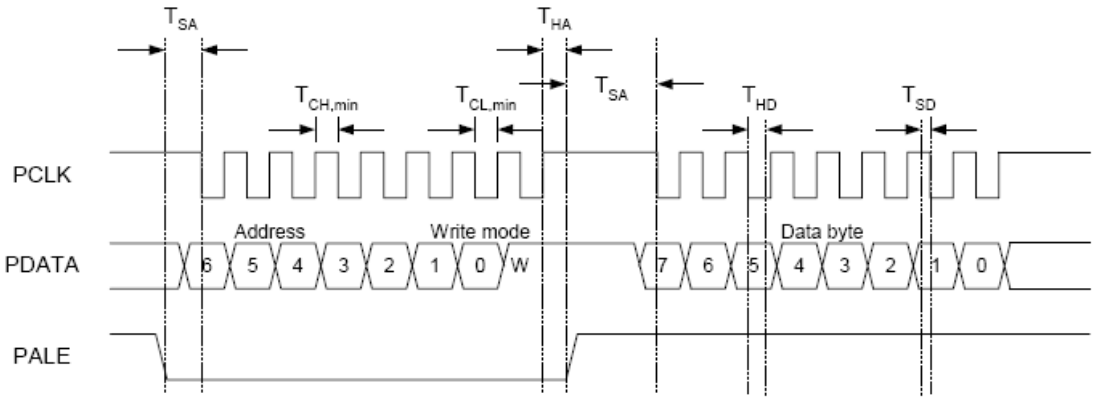

Figure 4: Timing diagram for Configuration registers write operation

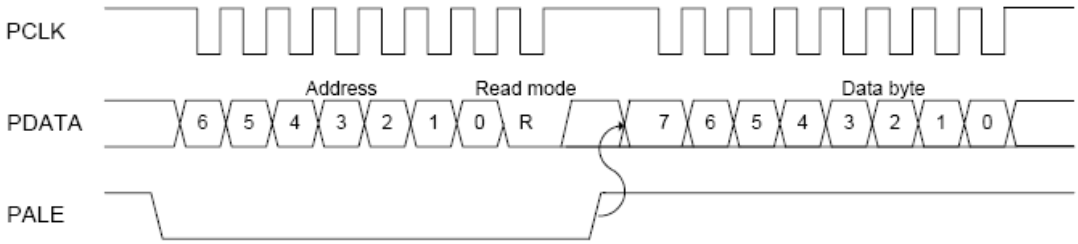

Figure 5: Timing diagram for Configuration registers read operation

- Interface to the bi-directional synchronous data signal interface: The signal interface consists of DIO and DCLK and is used for the data to be transmitted and data received. DIO is the bi-directional data line and DCLK provides synchronous clock both during data transmission and data reception. UART mode is used for data transmission and reception.

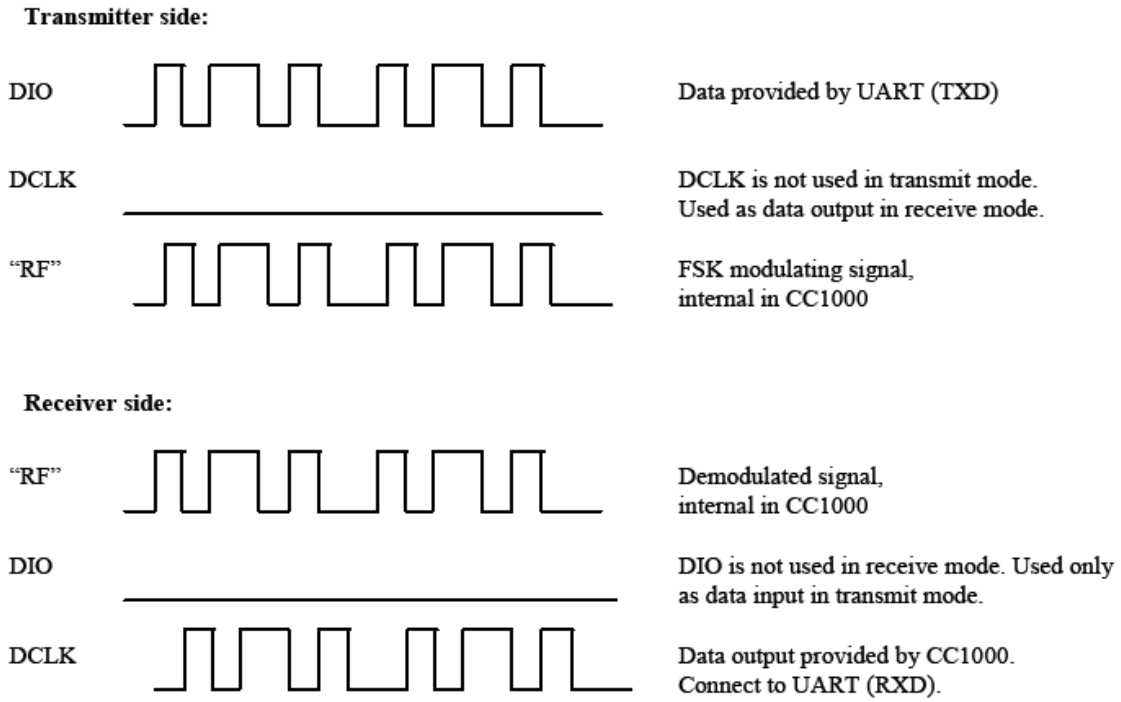

Figure 6: Transparent Asynchronous UART mode

4 Algorithms

Algorithms used for initialisation and calibration are shown in flowchart:

Turning on the power:
Initialising sequence for Chipcon1000 when power is turned on is shown in flowchart:

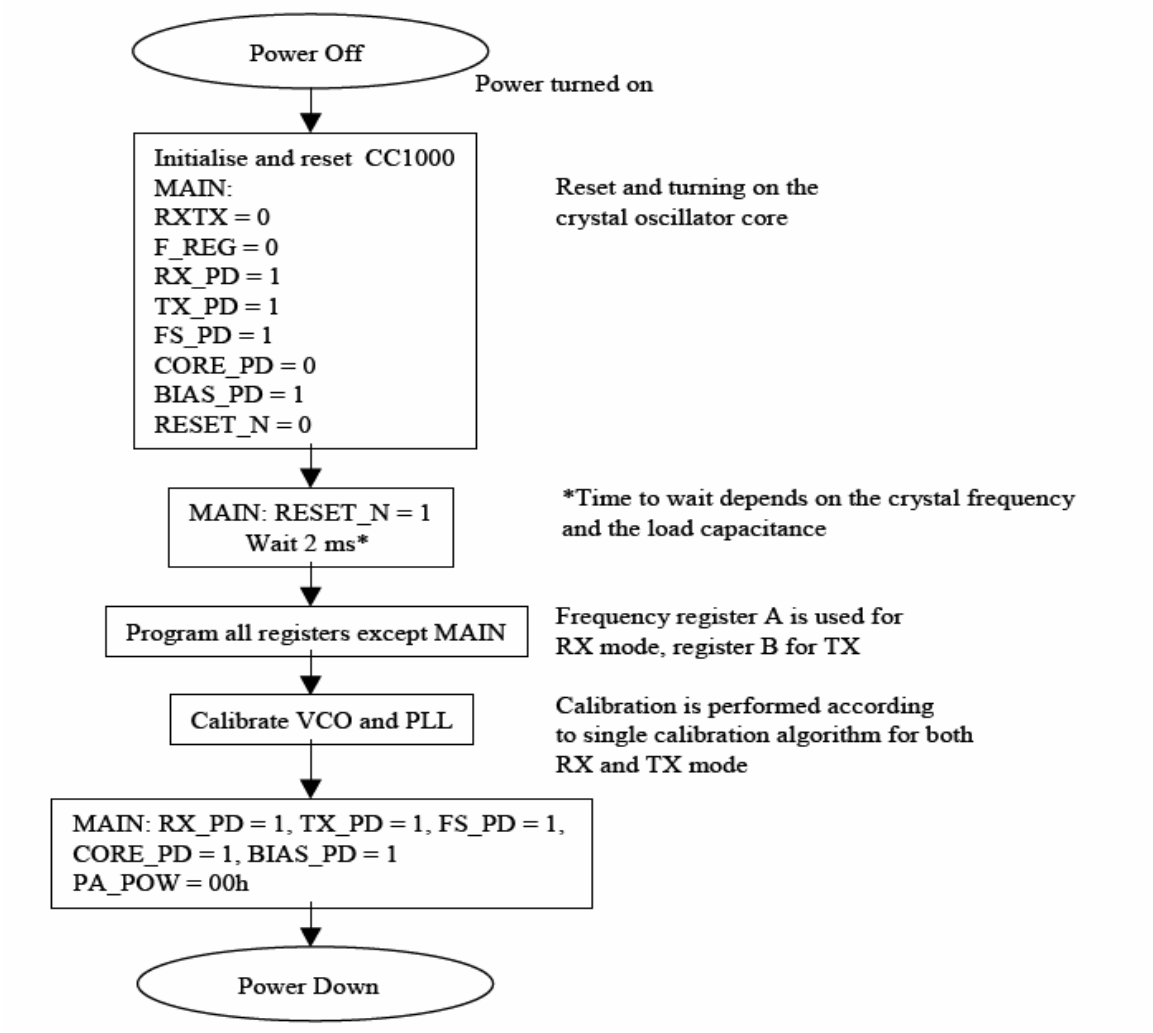

Figure 7

Flow Chart for single calibartion :

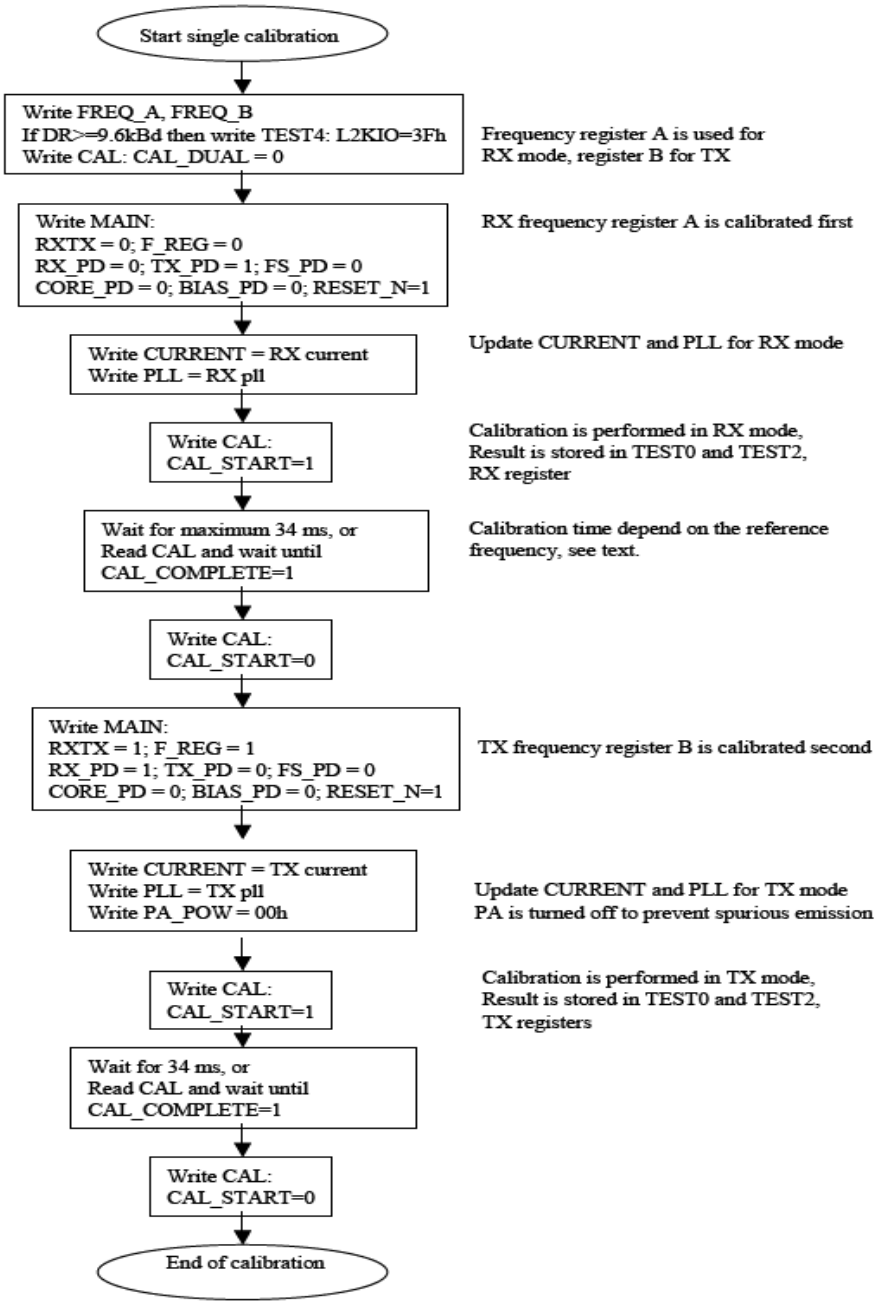

Figure 8

5 References

[1] User guide: MSP430X1XX family
[2] Application report: Features of the MSP430 Bootstrap Loader
[3] Datasheet: MSP 430X16X
[4] Datasheet: CC1000
[5] Application note: CC1000/CC1050 Microcontroller interfacing By K. H. Torvmark
[6] User Manual: SmartRF Studio User Manual 7

Acknowledgement

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