Ziosk Z-400 Platform
Operational Description

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Table of Contents

1 Introduction

This document will provide an overview of the Ziosk Z-400 platform system operation and a description of the radio section of the unit, which is an 802.11 a/b/g/n/ac WLAN module (plus Bluetooth 4.0 LE) used for network communications.

2 Definitions, Acronyms & Abbreviations

Android: a mobile OS based on the Linux kernel and currently developed by Google

Bluetooth LE: Bluetooth 4.0 Low Energy

DSSS: Direct Sequence Spread Spectrum

eMSR: encrypting Magnetic Stripe Reader

FHSS: Frequency Hopping Spread Spectrum

OFDM: Orthogonal Frequency Division Multiplexing

OS: Operating System

PCB: Printed Circuit Board

POS: Point of Sale

QAM: Quadrature Amplitude Modulation

SDIO: Secure Digital Input Output

UART: Universal Asynchronous Receiver/Transmitter

UI: User interface

U-NII: Unlicensed National Information Infrastructure

WLAN: Wireless Local Area Network

3 References

Approval_TableTop_Media_WiFi_Dual_Band_Antenna_FST150331.pdf (antenna datasheet)

EUT Photos Internal.pdf

4 System Overview

The Ziosk is a battery operated device intended for use at casual dining restaurants that allows guests to pay at the table and enables order entry, digital promotions, and infotainment. Movie trailers, games, and advertisements for food and drink specials are just a few of the capabilities that the device makes available to the restaurant patron.

An ARM-based microprocessor controls the various functions implemented on the device. Memory includes eMMC NAND flash for program and content storage, and mobile LPDDR2 SDRAM for system operation. The underlying operating system is Android-based, but the user interface is completely custom and does not provide the restaurant patron with the ability to change or modify the device configuration in any way, as a normal consumer tablet might.

A 7" LCD display incorporates a touch screen interface to allow interaction with the device. Peripherals include an encrypting magnetic stripe reader (eMSR) to collect credit card information, a thermal printer to provide receipts, and an 802.11 a/b/g/n/ac WLAN subsystem to connect to the point-of-sale (POS) system in order to retrieve the guest check and process payment. Stereo audio speakers are also included.

The battery is a custom Li-Ion pack which is rated to last approximately 18+ hours under normal usage conditions. With battery operation and wireless network access, the device needs no wiring infrastructure for deployment.

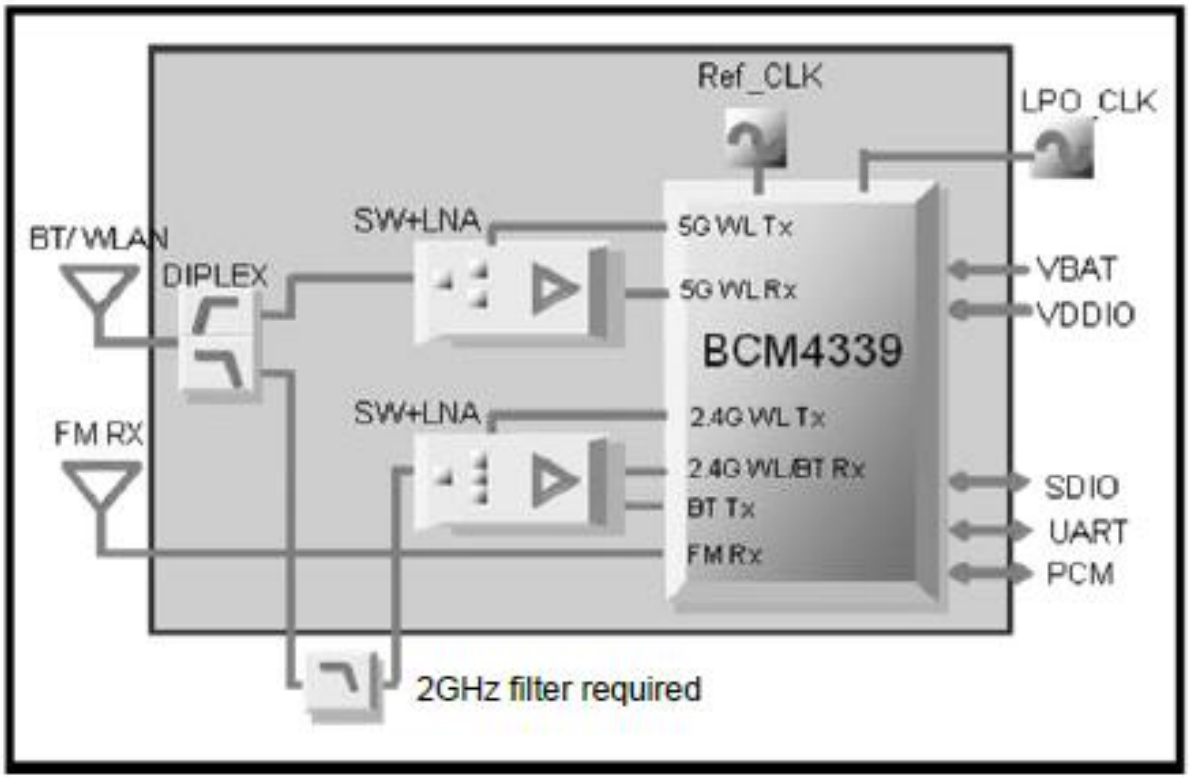
In operation, the guest may view promotional items offered such as appetizers, drink specials, entrees and the like. Information about the restaurant chain may be available, as well as email clubs and loyalty programs. Games for entertainment are provided, including several trivia games across different categories.

Content updates are remotely managed across a corporate network with a local server at each restaurant, and downloaded to each unit across the 802.11 WLAN connection. The same wireless connection allows each table's device to connect to the POS system in order to bring up the guest check at time of payment. The eMSR allows credit card data to be read and transmitted to the POS system, where the transaction is completed and the payment is processed. A receipt may then be printed, or emailed if desired. An LED is illuminated green to signify successful completion of the transaction or red to notify the wait staff of any problem.

5 RF Subsystem Description

The RF subsystem is designed in accordance with the IEEE 802.11 a/b/g/n/ac standards for wireless LAN. The Murata LBEH5HMZPC WLAN module was selected for this application due to its level of integration and ease of implementation. This module also provides Bluetooth 4.0 LE and legacy Class 1 Bluetooth operation.

The Murata module incorporates a Broadcom BCM4339 single-chip WLAN MAC Baseband Processor and direct conversion RF transceiver, along with directional switches and LNAs for both the 2.4GHz and 5GHz frequency bands, a diplexer to combine the two RF paths, and a 37.4MHz reference clock, all integrated into one package. A 2.4GHz low pass filter is implemented external to the module in the 2.4GHz path. A single antenna port provides the RF interface to a U.FL connector on the main PCB. A 32.768 kHz low power oscillator (LPO) clock signal is supplied from the host processor subsystem. The host side digital interface with the main system processor is SDIO for WLAN and UART for Bluetooth. Refer to the block diagram illustration below.



On the main PCB board layout (refer to EUT Photos Internal.pdf), a footprint for a metal shield to cover the WLAN module can be seen. The shield proved not to be necessary in order to pass radiated emissions, so no shield is used in production.

6 RF Operational Description

As mentioned above, the RF subsystem is designed in accordance with the IEEE 802.11 a/b/g/n/ac standards for wireless LAN. All modes of operation in both 2.4 GHz and 5 GHz bands are characterized and enabled for use, including the 5.15 – 5.25GHz U-NII-1 band, 5.25 – 5. 35 GHz U-NII-2A band, 5.47 -5.725 GHz U-NII-2C band, and 5.725 – 5. 85 GHz U-NII-3 band. In the 2.4 GHz band, only channels 1-11 are used - operation on channels 12 and 13 is not supported. In addition to 802.11 WLAN, Bluetooth 4.0 LE (and legacy Class 1) operation is also supported.

The WLAN module makes use of both DSSS and OFDM techniques – but primarily OFDM for the more recent, higher data rate transmission standards. Digital modulation schemes including DBPSK, DQPSK, and up to QAM256 are employed at the various data rates. Class 1 Bluetooth utilizes FHSS, while the Bluetooth LE transmission is classified as DSSS.

Maximum power levels for all of the modes of operation are set by firmware that gets loaded into the Broadcom BCM4339 chip by the WLAN driver. The firmware is a compiled image that is supplied by Broadcom and is read-only; there are no provisions in the driver or in any user interface to allow modifications or changes to these settings. The power levels are set as per the maximum levels specified in the Murata LBEH5HMZPC datasheet, and all testing was performed at these same levels.

Channel access is set by Android through a read-only property [ro.product.locale.region]: [US]. This property is determined at OS build time. There is a module in Android Wi-Fi to control the regulatory domain according to this parameter. Once set, there are no provisions in the UI that allow any configuration changes to be made to this setting. For 40/80 MHz channels, the WLAN driver selects which adjacent channel to use automatically.

The use case for the wireless subsystem on Ziosk is typical for network server access through commercial access points. The Ziosk is considered a client device for WLAN applications; it does not perform any non-standard RF tasks. When the device is connected to an access point, it automatically stops transmission if there is no relevant data to transmit - except for the standard management and control frames such as probe requests and power saving hand-shakes. When the device is not connected or fails to connect, it only transmits standard management frames such as probe, association, and authentication requests.

7 Antenna Description

The antenna used in the device is an embedded PCB type, attached to the circuit board in the upper left-hand corner by double-sided tape, and connected to the WLAN radio module through a short length of coax cable, terminated in a U.FL connector. It is contained wholly inside the plastic housing of the device, and is not accessible by the user.

The table below lists a summary of the gain characteristics in the 2.4GHz and 5GHz bands. Refer to datasheet (Approval_TableTop_Media_WiFi_Dual_Band_Antenna_FST150331) for details.

Note: The datasheet lists data specified for Antenna 1 and Antenna 2; these refer to two different positions that the antenna was characterized at. The Ziosk is built with the antenna in the position of Antenna 1 ONLY.

Freq (MHz)	Eff. (%)	Avg (dBi)	Peak (dBi)	Θ (deg)	φ (deg)
2400.000	31.34	-5.04	0.83	30.00	90.00
2450.000	28.93	-5.39	0.46	15.00	105.00
2500.000	27.13	-5.66	-0.05	30.00	90.00
5150.000	35.25	-4.53	2.54	45.00	105.00
5250.000	29.96	-5.24	1.31	30.00	120.00
5350.000	21.79	-6.62	-0.69	30.00	45.00
5470.000	50.62	-2.96	2.75	75.00	105.00
5725.000	32.38	-4.90	1.94	45.00	90.00
5825.000	25.82	-5.88	0.93	30.00	90.00