OK-01 iKeg Sensor Manual

1 Product Overview

The iKeg Sensor is a device that mounts to the bottom of beer keg, takes periodic measurements of the remaining beer in the keg and transmits this information wirelessly to an iKeg Uplink. To implement this function, the hardware shall consist of the following features：

1) Weight Sensing Load Cells
2) 1 Battery
3) Controls and Indicators
   a. 1 Red LED
   b. 1 Momentary Push Button
   c. JTAG header
4) 1 or 2 Printed Circuit Boards incorporating:
   a. Battery Management / Power Supply
   b. Central Processing Unit (CPU)
   c. Wireless Communication Interface to the iKeg Uplink
   d. Analog to Digital Conversion (ADC) of the Load Cells
   e. Radio Frequency Identification (RFID) Reader w/ Antenna

1.1 iKeg Sensor Lifecycle

Upon arrival at the retailer, the battery tab will be removed or the battery otherwise inserted or the unit paired to wake up from its deep sleep state. At initial power up, the iKeg sensor will only seek to associate with a gateway and activate itself. After association and activation, it will enter its idle or heartbeat state. In this state it is asleep and can only be awakened by the expiration of an internal counter or by pressing the Pairing button. At the expiration of the counter it will send a Heartbeat Mode Status to its associated gateway. This is intended to give the gateway an opportunity to pass any necessary messages to a particular iKeg sensor while maintaining a minimum load on the battery. The gateway will otherwise not be able to communicate with the sensor while it is asleep.

Once the sensor has been successfully activated it can be put into service whereby the iKeg sensor will be paired with a container. The delivery driver can put the sensor into its pairing state by pressing the pairing button. In the pairing state the sensor will activate its RFID reader, light it's red LED steadily to let the driver know it is ready to be paired. The driver will then swipe the sensor across the RFID tag on the container. If the pairing is successful, the

LED will blink briefly and then turn off. If the sensor's remaining battery level is below a threshold such that it will not be able to accurately track the weight of a keg, it will leave it's LED off and emit NO audible alert. It will essentially appear dead to the delivery driver as an indication that it needs to be removed from service. In the event that no valid RFID tag is read within a TBD timeout, the sensor will turn off the LED and retain its previous pairing information. If the sensor unsuccessfully exits the pairing state, it will return to the heartbeat state.

If however the pairing is successful, the iKeg sensor will enter its monitoring state. In this state the sensor wakes up based on its programmed interval and time slot allocation to report its container fullness level to its associated uplink. Upon successfully sending the fullness level message, the uplink may also request further status or provide further programming to the sensor. The sensor will also update any of its other status monitoring features prior to going back to sleep. There are several possible exits from the monitor state.

First, if a container's fullness level has not changed over the last TBD readings it may report to an uplink that it will enter a monitoring heartbeat mode where it will continue to monitor container fullness, but will not report any fullness readings until such time as there is a change in the readings. This is meant to minimize the on time of the wireless network radio and thereby maximize the battery life. When the container level begins to change again it will return to its monitoring state.

Second, if the container reaches empty it may report to an uplink that it will exit monitoring mode and go to heartbeat mode (no further monitoring). It will remain in heartbeat mode until the next time it is paired with a new container.

Third, if the pairing button is pressed and a successful pairing cycle is completed, the sensor will return to the monitoring state with the newly paired container. If the pairing request is not successful, the sensor will return to monitoring its presently paired container.

In the case where a sensor fails to pair, the delivery driver will remove the particular sensor from the retailer premises and return it to the distributor. The distributor in turn will collect all non-functioning sensors and return them on a periodic basis to a refurbishment center, which will replace the battery, update firmware (if necessary), and test the sensor. If it is functioning normally, it will then be returned to be redeployed, or drop shipped to a distributor for redeployment.

If the sensor fails testing, the battery is removed and the sensor (along with other non-functioning sensors) is sent to a recycling center, which may attempt to repair the sensor or if that is not feasible, dismantle the sensor components for recycling or disposal.

The refurbishment and recycling functions may be co-located.

1.2 Weight Sensor Function

The iKeg Sensor shall contain four (4) weight sensor load cells. The basic function is to measure the weight of a beer keg sitting on top of the iKeg sensor. This weight serves to indicate the amount of beer remaining in the keg.

1.3 Battery and Power Supply Function

The iKeg battery provides power to all of the components of the iKeg sensor. The battery must have current limiting capabilities to protect itself against short circuits or thermal overload. Battery life at low temperatures will also be a key performance parameter of the iKeg sensor. In order to minimize current draw and maximize battery life, the peripheral functions of the iKeg sensor will be managed by the CPU using switched power supplies. The iKeg Sensor must also be capable of monitoring the battery voltage in order to estimate the remaining battery life of the sensor.

1.4 Controls and Indicators

The iKeg sensor is intended to have a minimum number of user accessible controls and indicators. The information from the iKeg sensor is mainly intended to be sent to the cloud service for remote action. Thus the local controls and indicators are only used for actions requiring immediate attention. There is a momentary push button to facilitate RFID pairing of the iKeg sensor to a beer keg and there is a red LED to indicate the functional status of the iKeg and its pairing state. Controls and indicators must be easily accessible to the user.

1.5 CPU / Wireless Communications

This iteration of the iKeg Sensor shall use the Freescale MC13224V integrated circuit, which incorporates multiple functions from the block diagram in Figure 1. It provides the CPU (ARM 7), Eight channel ADC to connect the weight sensor load cells, battery level sensing, and a Zigbee compatible 2.4GHz wireless radio module in addition to general purpose interfaces for the RFID, controls, and indicators. For the PT4 or D version of the iKeg Sensor the CPU function will be split with the MC13224V IC handling wireless communications and a Microchip PIC16F1829 paired with a TM7711 ADC handling the weight readings and calibration, RFID reader, and the push button and LED.

1.6 RFID Reader

The iKeg Sensor shall employ an RFID reader to facilitate pairing with a beer keg which will have an RFID tag containing a 64-bit value programmed which will typically indicate the beer brewer and style among other parameters. The reader must be able to read NXP Mifare Ultralight tags and optionally support other Mifare family devices.

2 System Requirements

2.1 Weight Sensor Function

The iKeg Sensor shall contain four (4) individual load cells used for measuring the weight of a keg or in the case of stacked kegs, two (2) kegs. The load cells shall be connected to the ADC inputs of the CPU via an analog signal conditioning network. Except as noted above, for this revision, the sensor may employ a dedicated weight sensing circuit with separate ADC and CPU functions. Key functional parameters are outlined below.

Parameter	Min	Typ	Max	Units
Weight Range Functioning	0		360	Lbs
Weight No Damage			360	Lbs
Impact No Damage (1ft drop w/ full keg)			10	Impacts
Impact No Damage (5ft drop w/o keg)			100	Impacts
Number of Weight Increment Readings Across Functioning Range	360			Increments
Weight per Increment Reading			1	Lbs/Increment
Weight Reading Accuracy (including any effects of drift, temperature, aging)			+/-2	Lbs
Weight Reading Data Size		16		bits
Special Codes				
-Error		0xFC00		

2.2 Battery and Power Supply Function

Parameter	Min	Typ	Max	Units
Temperature Operating	32	38	100	Degrees F
Temperature Non-Operating	0		125	Degrees F
Battery Life @ 38^{o}F Operating (10% Charge Remaining)	9			Months
Battery Life Across Non-Operating Temperature Range (75% Charge Remaining)	2			Years
Battery Voltage Indicator Increment	0.1			Volts
Battery Voltage Indicator Accuracy			+/-.05	Volts

2.3 Controls and Indicators

Parameter	Min	Typ	Max	Units
LED Intensity	10	25		mcd
LED Maximum Current			10	mA
Button Minimum Endurance	10,000			Presses

2.4 Zigbee Wireless Transceiver

Parameter	Min	Typ	Max	Units
Wireless Transmission Range Unobstructed	100			ft

Wireless Range Obstructed (iKeg sensor located in the middle of 4 kegs arranged in a square with an additional 4 kegs stacked on top of the bottom 4 in a sealed cooler room transmitting to an Uplink outside the cooler)	50			ft
Minimum Transmit Power	+10			dBm
Minimum Receive Sensitivity	-100			dBm

2.5 RFID Reader

The RFID reader shall be compatible with NXP Mifare Ultralight RFID tags. It may optionally be compatible with other NXP Mifare family tag products.

The reader should specifically read back a 64-bit (8 byte) value from pages 0x04 and 0x05 of the Mifare Ultralight tag where each page contains a 4 byte word. The tag's UID value is stored in pages 0x00 and 0x01. We are intentionally not using pages 0x02 and 0x03 as they contain further special purpose bits on the Mifare Ultralight tags. User information will be programmed into the 8 bytes stored on pages 0x04 and 0x05 of the Mifare Ultralight tag.

The iKeg Sensor shall also be capable of reading and storing 2 separate RFID tags for the purpose of supporting stacked kegs. The operation shall be as follows. To pair with the primary keg, an RFID tag read shall be initiated by pressing and holding the button until the LED is lit. The primary tag will then be placed over the RFID reader antenna. When the tag has been successfully read, the LED shall blink twice and then go out. To pair with a secondary (stacked) keg, the button will be pressed and held until the LED is lit. Pressing and holding the button a second time while the LED is lit shall trigger the RFID reader to read and store the next RFID tag to a secondary location indicating it is a keg stacked with the keg RFID tag stored in the primary tag location.

When used with the iKeg sensor we want the range intentionally limited to less than 6 inches to avoid interference with other nearby tags. In the iKeg sensor environment we want to make sure we can only see 1 tag at a time. Further, the iKeg sensor need only contain an RFID reader IC.

Further information regarding the Mifare Ultralight tags can be found in the Mifare Ultralight Tag datasheet referenced in Section 1.3.

Parameter	**Min**	**Typ**	**Max**	**Units**
Tag Memory	64			Bytes
Tag Power Consumption		Field Powered		mA
Tag RF Range	1		6	inches
Tag Rewrite Cycles	100			Cycles
R/W Power Consumption Transmitting			100	mA
R/W Host Software Driver Size			8	KB

3 FCC STATEMENT

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC RF Radiation Exposure Statement Caution: This Transmitter must be installed to provide a separation distance of at least 20 cm from all persons.