ISWM Wireless load cell standard

ISWM 1115.0

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International Society of Weighing & Measurement
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1. Modes

There are two modes of operation that will be considered

1.1 Normal Operation

1.1.1. Coordinator continuously receives data from each wireless load cell and comminicates with the indicator or other device.

1.1.2. Wireless load cell(s) continuously transmit load data.

1.2 Initialization (power up)

1.2.1 On Power Up the coordinator will form a ZigBee network with pre-assigned (IEEE address) wireless load cells.

1.2.2 The wireless load cells will join the network

2. Definition of terms

Application Profile
: A set of network characteristics that are used by all wireless load cells and coordinator/indicators to insure inter-operability of different manufacturer's and developers products.

Band
: Frequency of RF (Radio Frequency) communication. For example ZigBee operates in the industrial, scientific and medical (ISM) radio bands; 868 MHz in Europe, 915 MHz in the USA and Australia, and 2.4 GHz in most jurisdictions worldwide. (Source: Wikipedia, ZigBee)

Chip Vendors
: ZigBee chip vendors typically sell integrated radios and microcontrollers with between 60K and 128K flash memory, such as the Jennic JN5148, the Freescale MC13213, the Ember EM250, the Texas Instruments CC2430, the Samsung Electro-Mechanics ZBS240 and the Atmel ATmegal 128RFA1. Radios are also available stand-alone to be used with any processor or microcontroller. Generally, the chip vendors also offer the ZigBee software stack, although independent ones are also available. (Source: Wikipedia, ZigBee)

Cluster
: A set of data structures and procedures that make up a ZigBee application.

Cluster ID
: An identifier for a cluster within an application in a ZigBee network. The ID provides a logical connection between a message and the data and procedures that send or receive a message.

Coordinator
: A ZigBee device which is located within or near the weight indicator. It will get the data from the router or end device (load cell) and pass it on to the indicator. ZigBee Coordinator (ZC) is the most capable device. The coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It is able to store information about the network, including acting as the Trust Centre & repository for security keys. (Source: Wikipedia, ZigBee)

End Device
: A ZigBee device located within or near a load cell. ZigBee End Device (ZED) contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC. (Source: Wikipedia, ZigBee)

End Point
: The logical connection between the ZigBee application on a device and the network components which make network connections, send and receive messages for the device. By separating the application from network functions and connecting through the end point, the application is relieved of network management tasks. Messages are sent from and delivered to Application End Points. The End Point Description contains information necessary to send and receive messages.

IEEE address	A 64 bit (8 byte hexadecimal) value which uniquely identifies a ZigBee device. This number can be assigned by the manufacturer of the device. It is commonly referred to as the MAC address which is a hardware address that uniquely identifies each node of a network. In IEEE 802 networks, the Data Link Control (DLC) layer of the OSI Reference Model is divided into two sublayers: the Logical Link Control (LLC) layer and the Media Access Control (MAC) layer. The MAC layer interfaces directly with the network medium. Consequently, each different type of network medium requires a different MAC layer. On networks that do not conform to the IEEE 802 standards but do conform to the OSI Reference Model, the node address is called the Data Link Control (DLC) address.
Indicator	Weight indicator used to display the weight in a scale or weighing system. It gets the weight data from the ZigBee coordinator which will be within or near the indicator.
Load cell	A device in a scale or weighing system to convert force to an electrical signal. The ZigBee router or end device will be within or near the load cell.
Router	A ZigBee device located typically within or near a load cell. It will get the data from the load cell and transmit the data to the coordinator (Indicator). ZigBee Router (ZR) can run an application function and it can act as an intermediate router, passing on data from other devices. (Source: Wikipedia, ZigBee)
ZigBee	IEEE 802.15.4 One of several wireless transmission protocols. It is adapted to longer distances than Bluetooth and is made for control and data rather than video or audio.

3. ZigBee load cell application

There are (3) devices types and (3) message formats using ZigBee wireless load cell applications.

3.1. Devices
- 3.1.1. Coordinator
  - 3.1.1.1. The coordinator is associated with the Indicator
  - 3.1.1.2. The coordinator may be an integral part of the Indicator (Integrated) or a separate device.
  - 3.1.1.3. The coordinator runs the indicator component of the application.
- 3.1.2. Router
  - 3.1.2.1. The router is associated with the load cell and converter.
  - 3.1.2.2. The router runs the wireless load cell component of the application.
  - 3.1.2.3. The router has the capability to accept messages from coordinator and end devices and transmit (route) them to their destination.
- 3.1.3. End device
  - 3.1.3.1. The end device is associated with the load cell and converter.
  - 3.1.3.2. The end device runs the wireless load cell component of the application.
  - 3.1.3.3. The end devices may at times be determined by the application to “sleep” to preserve battery life.

3.2. ZigBee Over-the-Air Messages
- 3.2.1. Opening message, router/end device to coordinator
- 3.2.2. Response to opening message, coordinator to router/end device
- 3.2.3. Data message, router/end device to coordinator

Notes: Security is not used in the Wireless load cell network and messages are not acknowledged by the destination device, no ACK or NAK.

4. Operation

On power up, wireless load cells attempt to discover and join a ZigBee network with the same application profile by sending a broadcast opening message to all ZigBee devices. The router or end device is looking for a coordinator to connect with. The router or end device opening message contains a Cluster ID which defines the router's request as "looking for load cell network" and also includes the wireless load cells IEEE address. This message is periodically sent as long as the wireless load cells are not connected to a network.

On power up, coordinator determines from memory how many wireless load cells should be in the network and their IEEE addresses. The indicator or other device permanent memory will contain the number of wireless load cells and the IEEE addresses. When the coordinator receives a message from a wireless load cell with matching Cluster ID and IEEE address, the coordinator adds the wireless load cell to the network by assigning a network address and wireless load cell number for use in subsequent processing of data. The IEEE address and the wireless load cell number must be matched by the coordinator so that each initialization will keep the wireless load cell number (location in scale) matched with its IEEE address. The coordinator sends a response to the wireless load cell containing the coordinator's network address. This address is where data from the wireless load cell will be sent. A network address and load cell number is assigned each time a load cell is added to the network. Subsequent formations of the network, for example, on power down and power up, a different network address may be assigned but the wireless load cell number will continue to match the IEEE address. The IEEE address is the reference address and is used as the permanent assignment.

On receipt of the network connection message, the wireless load cell records the coordinator network address as the location where it will send data.

Typical operation, when the wireless load cell is connected to the network and receives the coordinator's network address, it will begin to transmit to the coordinator.

The indicator or other device will use a dynamic scheme to detect missing or stale data.

5. ZigBee parameters

5. A ZigBee message requires 8 parameter elements

5.1. **Address Mode:** Specifies how the message is to be sent and received. Three choices are available

5.1.1. Network Address Mode (also called the shortAddr) - the network address is a 16 bit address assigned by the network coordinator at the time that a network is formed or joined. A message using a network address is sent from the sending node directly to the addressed node.

5.1.2. IEEE Address Mode uses the destination device's 64-bit IEEE address. A message using an IEEE address is sent from the sending node directly to the addressed device.

5.1.3. Broadcast Address Mode uses a specific pre-assigned 16-bit value (0xFFF) of the network address. A message using t he broadcast address is sent from the sending device to all ZigBee devices in range.

5.2. **Address:** The designated network address, IEEE address or broadcast address of the destination device.

5.3. **End Point:** Specifies the application on a ZigBee device that sends or receives the message. The End Point Description contains the following data elements and information. Some elements may be optional.

5.3.1. End PointID	An identifying number for the application endpoint
5.3.2. AppProfID	Identifier for the application profile in use, if any
5.3.3. AppDeviceID	Information about the device
5.3.4. AppDevVer	Identification of the developer
5.3.5. Reserved	Reserved for future use (by ZigBee standards)
5.3.6. AppNumInClusters	Number of Cluster ID's which may receive messages
5.3.7. AppInClusterList	A list of Cluster ID's which may receive messages
5.3.8. AppNumOutClusters	Number of Cluster ID's which may send messages
5.3.9. AppOutClusterList	A list of Cluster ID's which may send messages

5.4. **Latency Req:** A value that specifies latency requirements. Choices are

5.4.1. No Latency Reqs

5.4.2. Fast Beacons

5.4.3. Slow Beacons

5.5. **Cluster ID:** Identifies the message source or destination component part of the application

5.5.1. A load cell network must have a unique cluster ID

5.5.1.1. Broadcast Cluster ID = 3

5.5.1.2. Data Cluster ID = 1

5.5.2. Format is binary Uint16 (16 bit unsigned integer)

5.6. **Message Length:**

5.6.1. The number of bytes that will be delivered to the message destination.

5.7. **Message:**

5.7.1. The message is constructed in memory with a number of fields depending on the application message type.

5.8. **Transmission radius:**

5.8.1. A measure of route cost

5.8.2. Uint8 (8 bit unsigned integer) normally set to AF_DEFAULT_RADIUS.

6. Wireless load cell ZigBee Message Details

6.1. ZigBee over the air message

6.1.1. The (3) over the air messages are constructed and sent with (8) standard parameters and formats (1-8).

6.2. Messages and formats

6.2.1. Wireless load cell opening message - sent by wireless load cell to coordinator

6.2.1.1. Address Mode: Broadcast Message

6.2.1.2. Address: The specific broadcast address specified by the software stack, usually 0xFFFF

6.2.1.3. Endpoint: 1

6.2.1.4. Latency Req: Any selection

6.2.1.5. Cluster ID: Load cell broadcast Cluster ID = 3, binary 3, often represented as 0x03

6.2.1.6. Message Length: 8 bytes

6.2.1.7. Message: Wireless load cell IEEE Address formatted as Little Endian (Least significant byte transmitted first).

6.2.1.8. Transmission Radius: Any selection

6.2.2. Coordinator response to wireless load cell opening message

6.2.2.1. Address Mode: IEEE Addressed Message

6.2.2.2. Address: The specific IEEE address of the device

6.2.2.3. Endpoint: 1

6.2.2.4. Latency Req: Any selection

6.2.2.5. Cluster ID: Load cell broadcast Cluster ID = 3, binary 3, often represented as 0x03

6.2.2.6. Message Length: 1 bytes

6.2.2.7. Message: ID Number - a single byte (Uint8) generated by the coordinator. This may be any number, including a random number that will be used as a message identifier by all wireless load cells in the network as long as the network remains operational.

6.2.2.8. Transmission Radius: Any selection

6.2.3. Wireless load cell load data message. Data element 7 has specific fields

6.2.3.1. Address Mode: Network Addressed Message

6.2.3.2. Address: The specific network address of the coordinator

6.2.3.3. Endpoint: 1

6.2.3.4. Latency Req: Any selection

6.2.3.5. Cluster ID: Load cell data Cluster ID = 1, binary 1, often represented as 0x01

6.2.3.6. Message Length: Variable, determined by content

6.2.3.7. Message: Consists of (3) fields

6.2.3.7.1. ID Field

6.2.3.7.1.1. Length: 1 byte

6.2.3.7.1.2. Field Data: ID Number received from coordinator in message #2 above

6.2.3.7.2. IEEE Field

6.2.3.7.2.1. Length: 8 bytes

6.2.3.7.2.2. Field Data: Wireless load cell IEEE address formatted as Little Endian (Least significant byte transmitted first)

6.2.3.7.3. Load Data Field

6.2.3.7.3.1. Length: Variable

6.2.3.7.3.2. Field Data:

6.2.3.7.3.2.1. Byte 1: “D” ASCII character upper case D identifying load cell data

6.2.3.7.3.2.2. Byte 2: “+” or “-” ASCII character plus sign or minus sign signifying sign of data.

6.2.3.7.3.2.3. Remaining Bytes: “12345” ASCII numeric characters representing load data, formatted as Big Endian (Most significant byte transmitted first)

6.2.3.8. Transmission Radius: Any selection