# i-B350 Tag with tilt monitoring for Beverage Metrics

# Design Specification

Project ID WINIK:         10120037         i-B350 BM Tilt PD (Beverage Metrics)

Project ID IFS:          200037          i-B350 BM Tilt PD (Beverage Metrics)

Version :         1.7
Author :         Karl Heinz Feierle  / Reinhold Gantner
Date :          8. Aug 2010

This design specification forms an integral part of the contract/ Purchase order/ Order confirmation and shall serve as the only valid technical specification document. This document will supersede all previous written, orally defined or in any other way defined definitions of the product.

# 1. Approval

| Unit | Date | Signature |
|---|---|---|
| Development Manager | | |
| Managing Director | | |
| Customer / Sales | | |

# 2. Confidentiality Note

**This document may only be circulated to those people involved in the project. The document may not be passed on to third parties without permission of IDENTEC SOLUTIONS AG.**

## 3. Version Overview

| Version | Date | Author | Remarks |
|---------|------|--------|---------|
| 1.0 | 01.June.2010 | Karl Heinz Feierle | Draft |
| 1.1 | 09.June.2010 | Karl Heinz Feierle | Add/Modify according to workshop results |
| 1.2 | 10.June.2010 | Karl Heinz Feierle | Formal corrections from Review |
| 1.3 | 17.June.2010 | Karl Heinz Feierle | Correct Dimensions, define colors, add updated pictures and drawings, |
| 1.4 | 28.June 2010 | Reinhold Gantner | Modified Unit for Voltage Measurements |
| 1.5 | 14.July 2010 | Reinhold Gantner | Added SW Version to Dormant Message |
| 1.6 | 4.August 2010 | Reinhold Gantner | Increased Number of Zones to 12 in the Pour Message |
| 1.7 | 8. August 2010 | Simon Prior | Add temperature sensor characteristics, change of Silicon color and dimensions, drawing update |

## 4. To do list

- Define communication interface of i-PORT M350 to edge device and branding station
- Define chemical resistance for BarCleaner
- Insert correct weight of the tag after receiving prototypes
- Define production process –> IDENTEC Operations
- Define method for dormant mode –> IDENTEC Operations
- Define pour measuring timeout (25 sec.) ?
- Decide about the feature of temperature and voltage measurement

# 5. Content

# 6. General

## 6.1. Introduction - System Overview

The end application is a system which will provide inventory and pour data of beverage bottles in a bar area, at banquet events and also in the bottle storage area. For that a Tag (RFID Transponder with sensors) is attached to the bottles.

A push button at the tag recognises if the tag is attached to or detached from a bottle.
The tag contains also a tilt sensor to measure tilt angle over g-force and recognizes pour events. With this data it should be possible to calculate the amount of liquid per pour event.
The tag is attached to the bottle via an elastic Silicone rubber band. All events are sent over air to a reader which is connected to an edge device. From there all the data are transferred to a server for further processing.
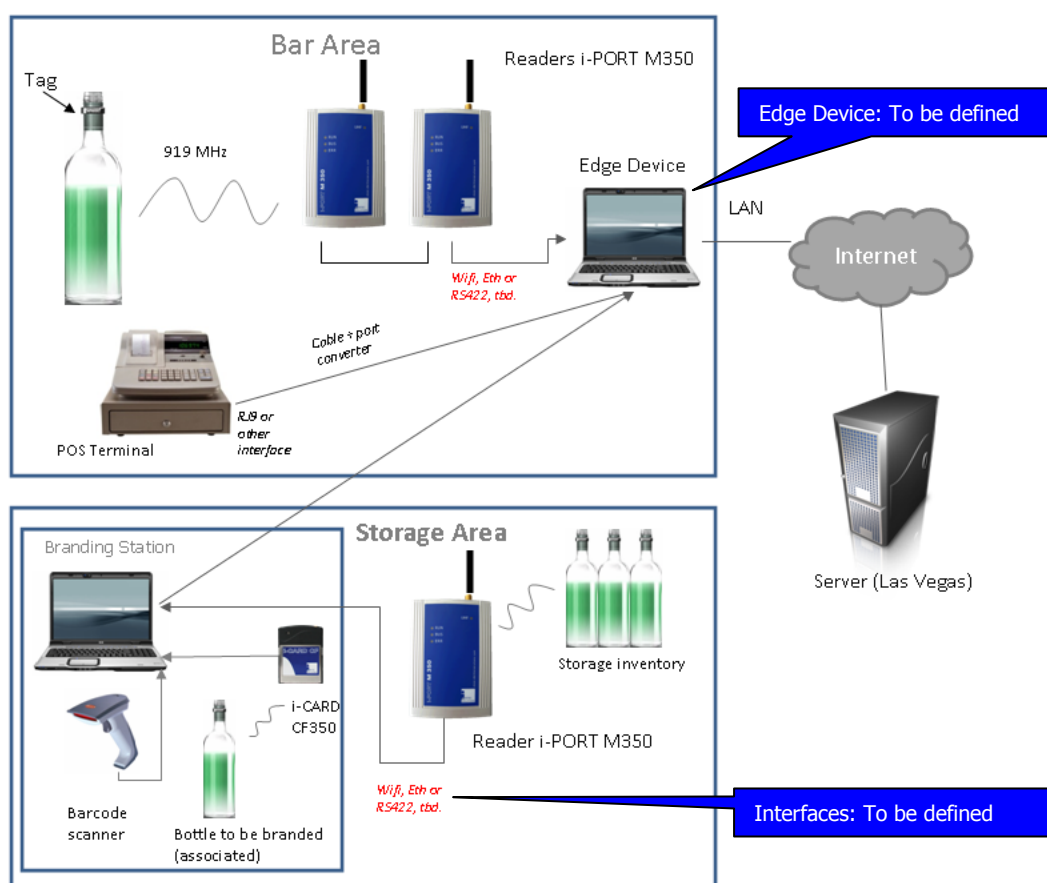
## 6.2. Project Content

This specification describes the tag itself and the firmware functionality only.  The tag described in this document is compatible to IDENTEC´s ILR 350 series.
IDENTEC is only HW provider and not responsible for the system design and system functionality.

Included parts:

- i-B350 compatible Tag with tilt sensor (broadcast only)
- i-PORT M 350 as reader device in the bar area (not content of this document)
- i-CARD CF 350 as reader in the branding station (not content of this document)

Not included parts:

- Application Software
- Cabling and installation
- Branding and POS stations (assuming some standard PC or Laptop)
- Edge Devices

## 6.3. Patents

IDENTEC is NOT responsible for eventually infringement of existing or pending patents. Beverage Metrics has to proof from a legal point of view that they can sell the product (Tag) as described in this document.

# 7. Hardware

## 7.1. Electronic and Sensors

### 7.1.1. Environmental Conditions

IP rating:                     IP65 (no dishwasher)
Humidity:                      10% to 90% relative humidity at 30°C non-condensing
Operating temperature:         -10° C to +60° C (+14°F to +140°F)
Storage temperature:           −20° C to +70° C (−4°F to +158°F)
Chemical resistance:           Drinking Alcohol, BarCleaner (tbd)

### 7.1.2. Tag housing

Outer Dimensions:              max. 45.4(W) x 22(H)  x 9(T) mm
                               – see Appendix A: drawing for explanation
Weight:                        30g (t.b.d. depends on housing material)
Protection class:              IP65
Colour:                        The Silicon is Beverage Metrics black
                               and the plastic is anthracic (Anthrazitgrau RAL 7016)
Material:                      combination of hard plastic (ABS) and soft silicone or rubber
Mounting:                      According to drawing in Appendix A
                               Mounting range bottle neck diameter: 25-38.5mm
                               Maximum Lip diameter: 45 mm (only during attaching)
                               Bottleneck conus: up to 10%

### 7.1.3. RF Characteristics

Number of antennas:            1 integrated PCB loop antenna
Mode of antennas:              transmit only
Frequency:                     Frequency is not configurable (fixed through crystal)
                               919.0 MHz (NA) or 868.2 MHz (EU);
Modulation:                    FSK ± 64 kHz at 115200bit/sec data rate
Range:                         30 to 60 m (100-200 ft) (bottle outside on bar, not inside metal shelf)
Output power:                  about 1mW – according to national regulations
Protocol:                      Identec i-B350 broadcast compatible packet
Data Format:                   See message description
Information content:           See message description
Number of tags in area:        Up to 5000, mostly around 1000 tags per site

### 7.1.4. Power Supply

Power source:                  1 pc. Battery CR 1632 Lithium Coin cell 3.0 V nominal (non-replaceable)
Battery Lifetime:              2-3 years (@ 6 min broadcast + 25 pour events per day = 270 messages)

### 7.1.5. Debug Interface

Type:                          similar to I2C, for production issues and debugging only
Configuration/FW Update:       Only over cable, without housing during manufacturing process

### 7.1.6. Accelerometer Measurement Characteristics

The values below will be calculated out of the measured value of the acceleration sensor. The thresholds for angle and time for the bottle status decision (pour, storage, attach, detach …) has to be defined.

Span:                           ± 1.5 g
Accuracy 0 g Offset:            ± 0.14 g
Resolution:                     0.047 g
Interval:                       6 min. or triggered by tilt switch

### 7.1.7. Tilt Switch Measurement Characteristics

Tilt switch angle:              ± 60° from vertical position

### 7.1.8. Temperature Measurement Characteristics

Resolution:                     0.1°C
Accuracy:                       ± 3°C

## 7.2. Labeling

### 7.2.1. Front Manufacturer Label

Tag needs to have a label with a barcode and human readable tag ID. It would be nice to have the barcode easily readable by common barcode scanning devices (without the need of a special high-resolution scanner because the barcode would be too small).

Dimension:                      30mm x 8.0 mm
Format:                         Code 128
Material:                       Identec coated label
Color:                          Text and barcode: black; Background: light silver or white

### 7.2.2. Front Marketing Label

For marketing purposes about half of the front side of the transponder housing is reserved for a customer specific label.

Dimension:                      about 30mm x 6.7 mm
Material:                        Customer specific (Not provided by Identec)
Color:                          Customer specific (Not provided by Identec)

### 7.2.3. Certification Information

For certification information (FCC, Canada, CE, Recycling, Type, Logo, ….) we will discuss with the housing manufacturer, if it is possible to put this information as a text structure in the inner part of the housing.

Otherwise we have to add an additional label, which will increase the overall cost of the tag.

# 8. Tag Block diagram

This is an example of the needed functional parts of the tag. The real parts could differ, due to technical and functional reasons.

**Picture: Electronics Functional Block diagram (for guidance only)**

Baseband Mikrocontroller
Tilt measurement

PCB loop antenna

Tilt Switch

Integrated
RF Transmitter

CPU

Acceleration
Sensor

Timing

Crystal

MEM

Power Supply
Coin Cell Li Battery
NOT REPLACABLE
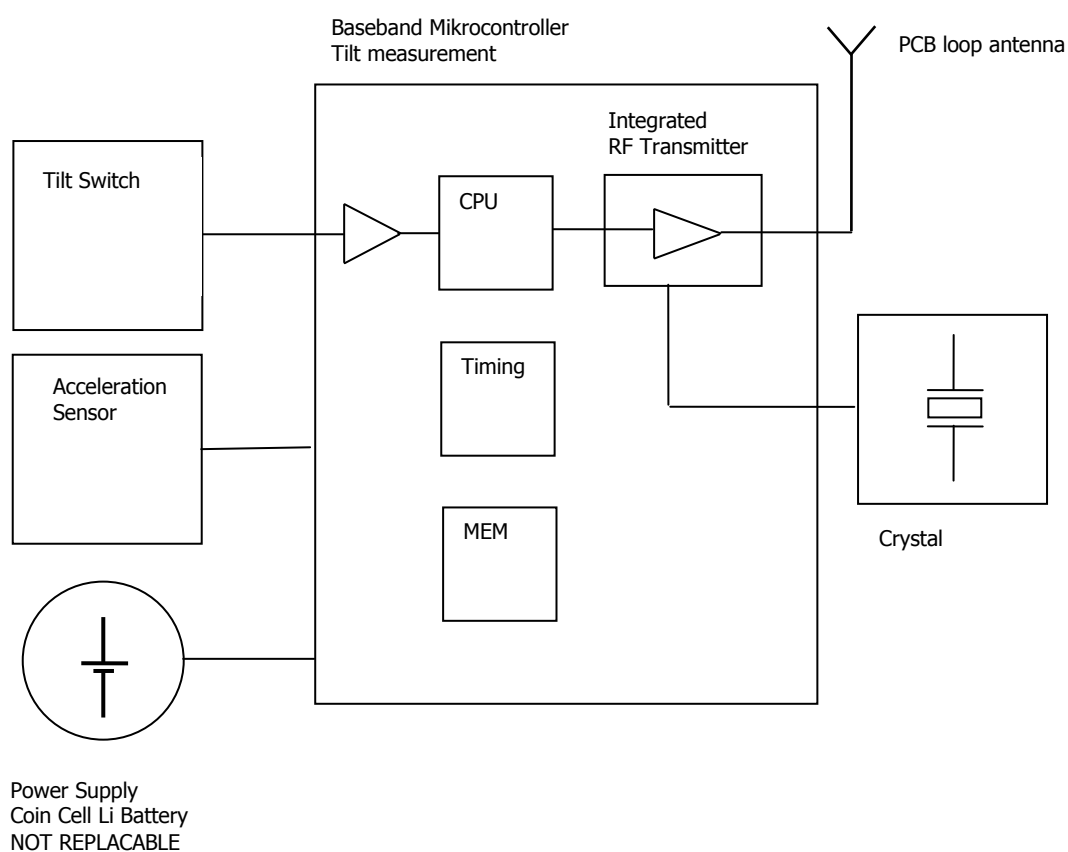
# 9. Firmware

The tag firmware is loaded during production process and initialized with its ID. Production process and behavior has to be defined with the operations team. The Tag will ship in DORMANT mode, meaning that no message is during this mode.

After pressing the push button the tag changes to INVENTORY ATTACH mode and sends a burst of six INVENTORY (ATTACHED) messages. It stays in INVENTORY ATTACH mode as long as the push button is pressed, sends cyclic every 6 minutes an INVENTORY (ATTACHED) message and monitors the tilt sensor.

By detecting a tilt event (angle over approximately 60° from vertical position) the tag starts measuring pouring time and tilt angle. After bringing back the bottle into upright position the tag recognizes the end of pour and sends a burst of six POUR messages, including the pouring duration times for every angle sector and the pour counter.

If the bottle was not brought back into vertical position in a defined (25 sec ?) time it will stop measuring tilt angle and set the pouring time to the maximum. It will not send a POUR burst in this situation (tbd). It will still send an INVENTORY (ATTACHED) message with the actual state.

When the tags is removed from the bottle it will send a burst consisting of six DETACHED messages and then stay in INVENTORY DETACH mode, send cyclic every 6 minutes an INVENTORY (DETACHED) message until the push button is pressed again or the tag was brought to DORMANT mode.

For shipping, transportation and long term storage the tag has the possibility to bring it into a dormant mode by pressing the push button 3 times in a 2 second time window – method to define.

The following messages are planned to fulfil the requirements:

- Inventory Attached
- Inventory Detached
- Attach
- Detach
- Pour
- Dormant

For a more detailed explanation on the messages please see below.

There is no possibility to configure the tag or to change the firmware after production process over air. The only possibility is to change the firmware manually over a cable when the housing is removed. Removing the housing can cause an irreparable damage of the housing itself.

It was decided to include the temperature and battery voltage measurement feature for the first 25,000 pieces, which will increase the cost of the tag $ 1.05.  If the feature is not needed in future devices it will removed and the cost remains the same.

## 9.1. Messages

### 9.1.1. Message Frame (over air)

Broadcast Tag ID including a predefined Message in a predefined Interval.
Data whitening is always used in this Telegram and the Baud rate is fixed to 115200 bit/s

| Preamble | Sync | Len | Cmd | | Data Field | | | | | | CRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Preamble | Sync | Len | Cmd | Status | Message Type | Manuf. ID | Tag Type | Tag ID | Beacon Counter | Message | CRC |
| 4 bytes | 2 bytes | 1 byte | 1 byte | 1 byte | 1 byte | 1 byte | 1 byte | 4 bytes | 2 bytes | Len - 10 bytes | 2 bytes |
| 1010...1010 | 0xCE09 | 10-62 | 0x41 | | 0x02 | 0x49 | 0x04 | | | | |

Status: Tag Status
                Bit[7]:              Battery (0 = good, 1 = low)
                Bit[6..4]:          For future use
                Bit[3..0]:          0: No Error
                                        1-15: Error code
Manufacturer ID:                Unique identifier of Manufacturer
Tag ID:                                Tag ID preset during manufacturing
Beacon Counter:              Bit[15..8]      Increments every $2^{20} = 1048576$ message
                                    Bit[7..0]        Increments every message

### 9.1.2. Inventory Message (Attached)

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **1** | - | 1 | | sent every 6 minutes |
| Pour Count | | - | 2 | Pours since last attachment | |
| Attach Duration | | 1.0 min | 2 | Duration since last attachment | |
| Reserve | **0x00** | | 1 | For future use | |
| X-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Y-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Z-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| Reserve | **0x0000** | | 2 | Barkeeper ID | 0x0000 = Not implemented |

### 9.1.3. Inventory Message (Detached)

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **2** | - | 1 | | sent every 6 minutes |
| Pour Count | | - | 2 | Pours since last attachment | |
| Detach Duration | | 1.0 min | 2 | Duration since last detachment | |
| Reserve | **0x00** | | 1 | For future use | |
| X-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Y-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Z-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| Reserve | **0x0000** | | 2 | Barkeeper ID | 0x0000 = Not implemented |

### 9.1.4. Attach Message

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **3** | - | 1 | | sent 6 times, 1 second after pressing the push button |
| Pour Count | **0** | - | 2 | Reset to zero at attachment | |
| Reserve | **0x000000** | | 3 | For future use | |
| X-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Y-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Z-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| Reserve | **0x0000** | | 2 | Barkeeper ID | 0x0000 = Not implemented |

### 9.1.5. Detach Message

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **4** | - | 1 | | sent 6 times, 1 second after releasing the push button |
| Pour Count | | - | 2 | Pours since last attachment | |
| Reserve | 0x000000 | | 3 | For future use | |
| X-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Y-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Z-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| Reserve | 0x0000 | | 2 | Barkeeper ID | 0x0000 = Not implemented |

### 9.1.6. Pour Message

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **5** | - | 1 | | sent as soon bottle is back in vertical position (+/- 60°) |
| Pour Count | | - | 2 | Pours since last attachment | |
| Pour Duration Zone A | | 0.1 sec | 1 | Duration of pour A G-Force zone | |
| Pour Duration Zone B | | 0.1 sec | 1 | Duration of pour B G-Force zone | |
| Pour Duration Zone C | | 0.1 sec | 1 | Duration of pour C G-Force zone | |
| Pour Duration Zone D | | 0.1 sec | 1 | Duration of pour D G-Force zone | |
| Pour Duration Zone E | | 0.1 sec | 1 | Duration of pour E G-Force zone | |
| Pour Duration Zone F | | 0.1 sec | 1 | Duration of pour F G-Force zone | |
| Pour Duration Zone G | | 0.1 sec | 1 | Duration of pour G G-Force zone | |
| Pour Duration Zone H | | 0.1 sec | 1 | Duration of pour H G-Force zone | |
| Pour Duration Zone I | | 0.1 sec | 1 | Duration of pour I G-Force zone | |
| Pour Duration Zone J | | 0.1 sec | 1 | Duration of pour J G-Force zone | |
| Pour Duration Zone K | | 0.1 sec | 1 | Duration of pour K G-Force zone | |
| Pour Duration Zone L | | 0.1 sec | 1 | Duration of pour L G-Force zone | |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| Reserve | 0x0000 | | 2 | Barkeeper ID | 0x0000 = Not implemented |

### 9.1.7. Dormant Message

| Field Description | Value | Unit | Bytes | Comments | Remarks |
|---|---|---|---|---|---|
| Event Type | **6** | - | 1 | | sent 6 times when entering dormant mode |
| Pour Count | | - | 2 | Pours since last attachment | |
| Reserve | 0x000000 | | 3 | For future use | |
| X-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Y-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Z-G-force | | 0.01g | 1 | Range: -1.27g …+1.27g | 0x80 = Not implemented |
| Temperature | | 0.1°C | 2 | | 0x8000 = Not implemented |
| Battery Voltage | | 1 mV | 2 | | 0x8000 = Not implemented |
| SW Version Major | | | 1 | | Example : Version 2.10 -> |
| SW Version Minor | | | 1 | Range: 0x00 – 0x063 | Major = 0x02, Minor = 0x0A |

## 10. Reader

The description of the reader is not part of this document.

## 11. Application Software

The description of the API is not part of this document.

## 12. Standards

This TAG has to comply with following additional standards for series production:

- FCC 15.247 (NA version)
- ETSI EN 300 220 (EU version)
- CE

## 13. Documents

## 14. Involved Staff

| Company | Name | Function | e-mail |
|---|---|---|---|
| Beverage Metrics | Marc P. Cornu | SVP Operations | mcornu@beveragemetrics.com |
| RadiantWave | Jim Dachelet | CEO | jimdachelet@RadiantWave.com |
| Identec Solutions | Simon Prior | Product Manager | sprior@identecsolutions.com |
| Identec Solutions | Reinhold Gantner | Project Manager Dev. HW FW | rgantner@identecsolutions.com |
| Identec Solutions | Daniel Kilga | FW | dkilga@identecsolutions.com |
| Identec Solutions | Michael Schmitt | Schematics, Layout | mschmitt@identecsolutions.com |
| Identec Solutions | Adalgiso Castrignano | SDK | acastrignano@identecsolutions.com |
| 3D - Design | Martin Fritsch | Mechanical Design | martin.fritsch@mf-3design.com |

## 15. Milestones and Deadlines

| Phase | Task/Milestone | Jun. 10 | Jul. 10 | Aug. 10 | Sep. 10 | Okt. 10 | Nov. 10 | Dez. 10 | Jan. 11 | Feb. 11 | Mar. 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elaboration | Preliminary Investigation | | | | | | | | | | |
| | Product Concept | | | | | | | | | | |
| | MS: Design Approval | | | | | | | | | | |
| Construction | Schematics/Layout | | | | | | | | | | |
| | Prototype Production (150 pcs) | | | | | | | | | | |
| | Housing Concept | | | | | | | | | | |
| | Tooling | | | | | | | | | | |
| | Prototype Assembly | | | | | | | | | | |
| | Delivery Prototypes 100pcs | | | | | | | | | | |
| | Production Prototypes (1800 pcs) | P | | S | | | | | | | |
| | Delivery Prototypes (1500pcs) | | | | | | | | | | |
| | FW Development | | | | | | | | | | |
| | FCC Certification | | | | | | | | | | |
| | Documentation | | | | | | | | | | |
| | SDK/Config Tool | | | | | | | | | | |
| | Release Testing | | | | | | | | | | |
| | System Integration | | | | | | | | | | |
| | MS: Prototype Approval | | | | | | | | | | |
| Transition | Production Tools/SW | | | | | | | | | | |
| | Pilot Test | | | | | | | | | | |
| | MS: Product Release | | | | | | | | | | |
| | Production (25.000pcs) | | P | | | | S | T | | | |
| | Delivery 23.500pcs | | | | | | | | | | |

| | |
|---|---|
| P | Procurement |
| S | Production Start |
| T | Testing |

**Milestones are subject to the acceptance of this document until 30st June 2010!**

## Appendix A: Housing Dimensions