

USER'S GUIDE: TITAN SMALLEST [US]

1. About tag components.....	2
1-1. Why Alien Higgs3?	
1-2. Memory architecture – Alien Higgs3	
1-3. Why glass fiber (PCB FR4) for packaging materials?	
1-4. Why wire bonding technology?	
1-5. Why gold plated antenna?	
2. About tag read performance.....	3
2-1. Main features (compared with other Titan tags)	
2-2. Tag location and read performance	
2-3. Tag orientation and read performance	
2-4. Tag attachment and read performance	
2-5. Environment and read performance	
3. About tag resistance	6
3-1. Operating temperature	
3-2. Storage and peak temperature	
3-3. Water ingress	
3-4. Static electricity	
3-5. Mechanical stress	
3-6. Chemical stress	
4. About tag attaching method.....	7
4-1. Backing adhesive tape, water, chemical and temperature	
4-2. Glue, water, chemical and temperature	
4-3. Polycarbonate bolt, mechanical stress and temperature	
4-4. Joint development – metal bracket	
5. About added service.....	8
5-1. Chip pre-programming	
5-2. Customized label	
5-3. Laser marking	
5-4. Direct (silkscreen) printing	

1. About tag components

1-1. Why Alien Higgs3?

- Because it's the best performing chip for metal mounting tags. Though it's most expensive, RFcamp has used Higgs3 – made by Alien Technology – since it was firstly released in 2008. Impinj has released comparably good chips – Monza4 and 5 – in recent years, but RFcamp will go together with Higgs3 in order to maintain our product consistency and keep trust among our long term customers.
- Nevertheless, RFcamp is always keen on new released chips from Impinj and NXP, and if we find out change of chips is needed for customer satisfaction, we will change it anytime.

1-2. Memory architecture – Alien Higgs3

- Higgs3 has total 800 bits memory, comprised of 96 EPC bits (extensible to 480 bits), 512 user bits, 64 bits unique TID, 32 bits Access and 32 bits Kill Passwords. Due to its flexible memory architecture, customers can easily allocate EPC and User memory for different uses. For further information, please contact RFcamp or visit Alien's website (www.alientechnology.com).

1-3. Why glass fiber (PCB FR4) for packaging materials?

- Because it's most stable and market proven materials in electric and antenna industries for + 40 years. Since year of 2004, RFcamp has focused on glass fiber as main materials for tag antenna substrates, while other tag makers focus on polymer, ceramic, etc. RFcamp has given #1 priority on product consistency and reliability, though pursuing new materials is also important.
- Recently, there appear several tag manufacturers who copy our glass fiber tags, but they can not copy our quality. RFcamp has unparalleled unique multi-layer PCB lamination technology, resisting against harshest water ingress and temperature conditions.

1-4. Why wire bonding technology?

- For tag manufacturers, choice of best chip attachment method is the most important, because it determines product reliability under harsh environment. Flip chip method, though it's cheapest, is vulnerable and weakest against temperature shock and mechanical stresses. Soldering method, though it's robust, is expensive and hard to work on small tags. Some says soldering is not costly. It's correct, however, only when they adopt cheap and low temperature soldering process. Tags from this cheap soldering method can not withstand > 120°C degree.
- RFcamp, therefore, has chosen wire bonding technology to achieve tag robustness in economical way, since established in year 2004.

1-5. Why gold plated antenna?

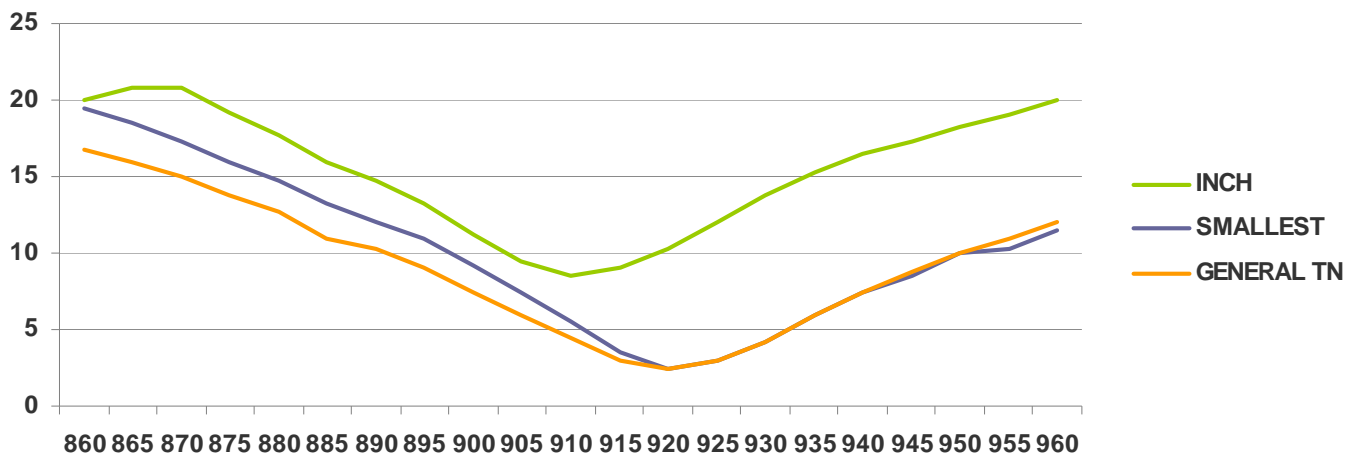
- Chip bonded strength on antenna is highest when antenna is plated gold. Compared with aluminum, copper or silver ink antenna, gold plated antenna enhance >30% higher strength.

2. About tag read performance

2-1. Main features (compared with other Titan tags)

- Despite its small form factor, SMALLEST's sensitivity curve shows that it's read performance on metal is almost same as that of GENERAL TN, 75mm*16mm*2.1mm. Among similarly sized metal mounting tag, SMALLEST is known as best performing tag in the world.
- Despite its unparalleled read performance, SMALLEST may be significantly influenced by its location on metal surface, tag orientation, etc.
- Users, therefore, must be very cautious about these influencing factors and must be contact RFcamp before tag installation.
- Here below graph shows sensitivity curve comparison among SMALLEST, INCH and GENERAL TN – All US version.

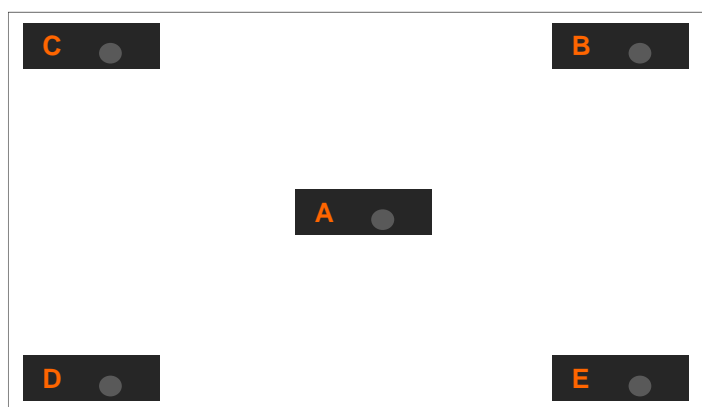
Sensitivity curve (X: MHz / Y: dBm)



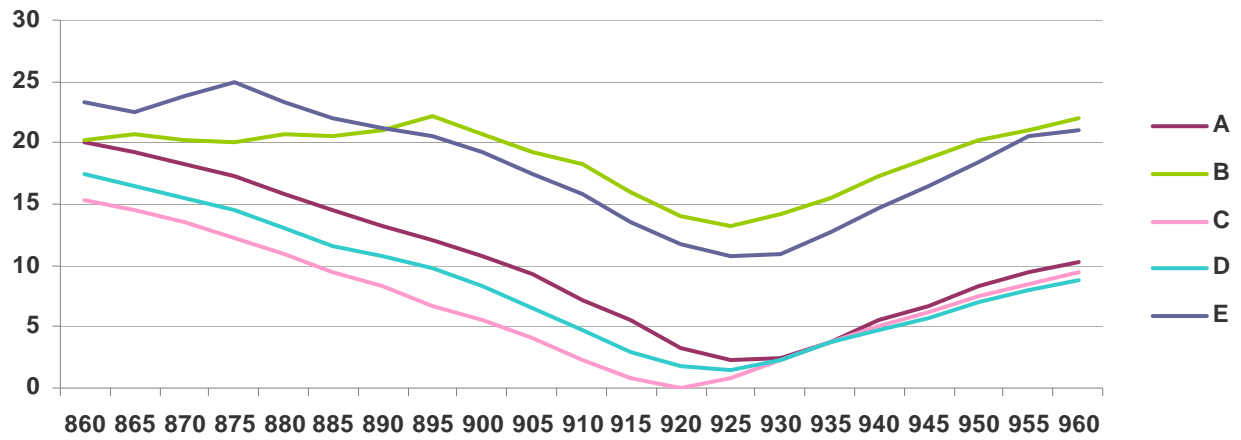
2-2. Tag location and read performance

- SMALLEST's read performance on metal surface is significantly influenced by tag location as A, B, C, D and E at picture right.
- See the graph on next page, and you can see that: location A, C and D performs good, whereas location B and E performs significantly behind.
- For further information, please contact RFcamp before tag installation.

Tag locations on metal surface

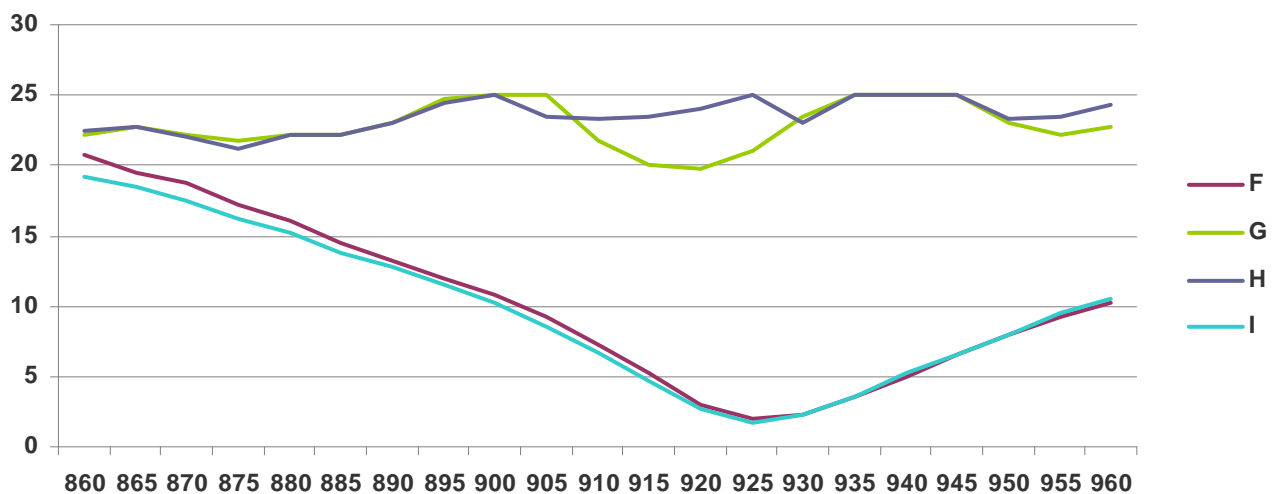
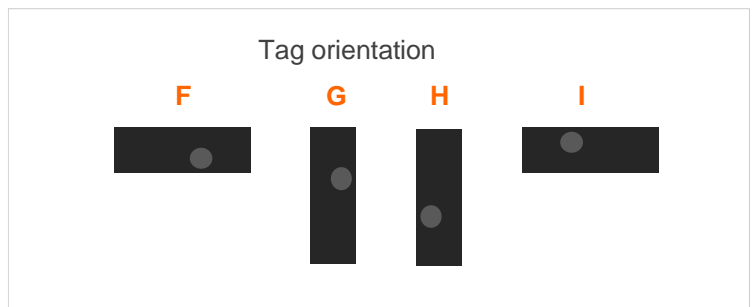


Sensitivity curve (Location)



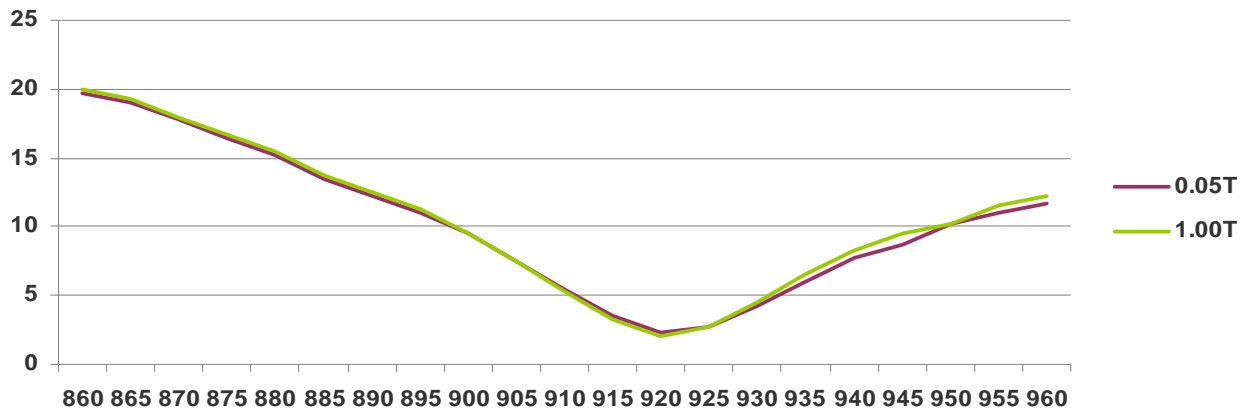
2-3. Tag orientation and read performance

- With rectangular feature, SMALLEST shows huge read performance difference by how it is oriented.
- See the picture right, and you can see four options of orientation as F, G, H and I and that F and I performs good, but G and H performs much behind.

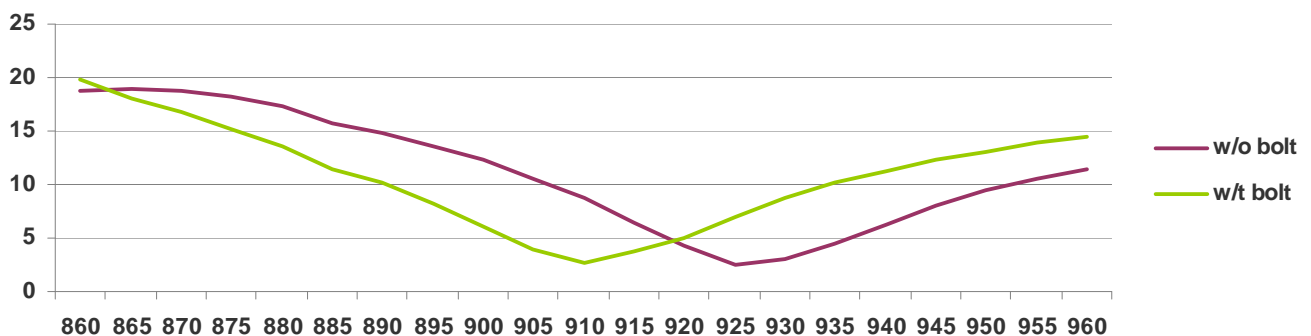


2-4. Tag attachment and read performance

•With its stable and broader band characteristics, SMALLEST's read performance is not much influenced by thickness of backing adhesive tape layer or glue. Users can use any range of 0.05 to 1mm thick backing adhesive without any sacrifice of read performance. See the graph below. There is no difference b/w 0.05mm and 1.00mm thick adhesive.



•Be cautious, when users apply metal bolt or screw, because it detunes tag resonant frequency. Here below is two curves – w/t and w/o metal bolts. It can be seen that 15MHz shifted down when metal bolts fastened.



2-5. Environment and read performance

- Temperature: Silicon RFID chips can work only within temperature range between -45°C and 85°C. When temperature goes beyond this range, its performance dramatically declines and at certain point becomes zero. Once temperature gets back in the range, its performance recovers in a few minutes. Even within the range, cold or hot environment may lower both tag and reader performance.
- Humidity: UHF tag performance is significantly influenced by humidity. In high humid atmosphere, tag read performance may decrease by 30% or more.
- Liquids: Just one drop of water on small UHF tag may decrease tag performance by up to 90%.
- RF interference and read performance: Tag performance is significantly influenced by RFI (Radio Frequency Interference) and EMI (Electro-Magnetic Interference). Also ESD (Electrical Static Discharge) may have effects on tag performance.

3. About tag resistance

3-1. Operating temperature

- Read page#5, first paragraph of 2-5.

3-2. Storage and peak temperature

- High temperature: Titan tags can withstand 180°C for 24hrs, 200°C for 6hrs and 208°C for a short time. RFCamp recommends Titan tags be applied at environments under 180°C. Contact RFCamp if environments require tags to withstand high temperature, pressure, mechanical stress and humidity all together.
- Low temperature: Titan tags can withstand -55°C for 168hours. Contact RFCamp if environments require tags to withstand low temperature and mechanical stress together.

3-3. Water ingression

- Titan tags is IP68 compliant, withstand able against 1 meter's water depth for 24 hours. It does not mean, however, tags maintain read performance in water.

3-4. Static electricity

- UHF Gen2 EEPROM silicon chips are comparatively weak against static electricity (ESD) and can survive only 2KV. With robust encapsulation, Titan tags can effective protect silicon chips and can survive 10KV.

3-5. Mechanical stress

- Titan tags have unparalleled robustness with to stable gold plated antenna, wire bonding, hardest epoxy chip encapsulation, and multi-layer fiber glass lamination under >180C degree.
- Please read product datasheet for further information on mechanical stress tests Titan tags have undergone.

3-6. Chemical stress

- Please read product datasheet for further information on chemical materials Titan tags can withstand against. If environments require tags to withstand other materials listed in product datasheets, contact RFCamp.

4. About tag attaching method

4-1. Backing adhesive tape, water, chemical and temperature

- For backing adhesive tape on SMALLEST, 3M300LSE (Also known as 9472LE) is applied.
- It can maintain its bond strength at 90% humidity over 7 days and in water for 100 hours. It can also survive several kinds chemicals including oil, mild acids and alkalis. It can effectively maintain its bond strength under temperature between -45°C and 150°C.
- For more information on 3M300LSE, please contact RFcamp or visit 3M's website (www.3m.com).
- If you require more extreme temperature or environments, contact RFcamp before searching for alternative by yourself.

4-2. Glue, water, chemical and temperature

- If your application requires higher adhesion under harsher environments, RFcamp recommends two kinds glue – (1) Cemedine's Super X (visit www.cemedine.co.jp) or (2) Loctite's 331 (visit www.loctite.com).
- Compared with 3M300LSE, these two glues are superior in keeping adhesion under water, various chemical materials, and broader temperature range.

4-3. Metal fastener, mechanical stress and temperature

Polymer bolts or screws can be applied for SMALLEST, but can withstand, however, only up to 130°C and is weak against any mechanical stress and is easy to loose. Metal fastener (e.g. bolts and screws) is robust, but may detune tag resonant frequency (as mentioned in 2-4, page #5).

4-4. Development of metal bracket

- RFcamp recommends users discuss metal (or polymer) bracket development with RFcamp from the beginning. Sometimes bracket's effects on tag read performance is too significant that tag should be modified or re-developed in order to maintain user's required minimum read performance.
- RFcamp believes that most time and cost saving way is to discuss in details with RFcamp.

5. About added service

5-1. Chip pre-programming

- Please note that RFcamp provides chip pre-programming service only for EPC memory sector, not for User memory sector. Alien Higgs3 chips, with its flexible memory architecture, can allocate 512 bits to EPC memory sector. (see 1-2, page#2). Therefore, RFcamp can pre-program chips with codes from 16 bits (4 digits decimal or hex or ASCII) to 512 bits (128 digits decimal or hex or ASCII), upon users' request. Please note that pre-programmable codes be 4 multiple digits.
- Please send chip pre-programming data as Microsoft Excel format or just starting/ending data, if sequentially serialized. RFcamp can pre-program 50K tags on daily basis.

Pre-programmable?	Yes	No
4 multiple digits	0001 99023100 123456781234567812345678	00001 : 5 digits 990231 : 6 digits 12 : 2 digits
Decimal, hex or ASCII	1A234CF0	013456P4 : P - Not programmable

5-2. Customized label

- RFcamp provides quick and reasonably priced customized label service. Standard label media, Avery Dennison made, is white or yellow paper, with polymer film over-laminated for water proof and hard to tear purpose. ZEBRA thermal transfer barcode printer with BARTENDER software prints out variable data with text as well as 1D/2D barcode.
- If users want their own multi colored symbol or logo, please send Adobe Illustrator or Corel Draw file first and discuss cost and lead time.

5-3. Laser marking

- For more robust marking under high temperature, RFcamp recommends direct laser marking on tag surface. With etched yellow color, It can mark variable data and text as well as 1D/2D barcode.
- If users want their own symbol or logo, please send Adobe Illustrator or Corel Draw file first and discuss cost and lead time.

5-4. Direct (silkscreen) printing

- If users want multi colored symbol or text under harsh environment, RFcamp recommends direct mark on tag surface by silkscreen printing. Only fixed data can be printed.
- If users want their own symbol or logo, please send Adobe Illustrator or Corel Draw file first and discuss cost and lead time.