

USER'S GUIDE: TITAN SMALLEST MAG [US]

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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.

1-6. Magnet types and features

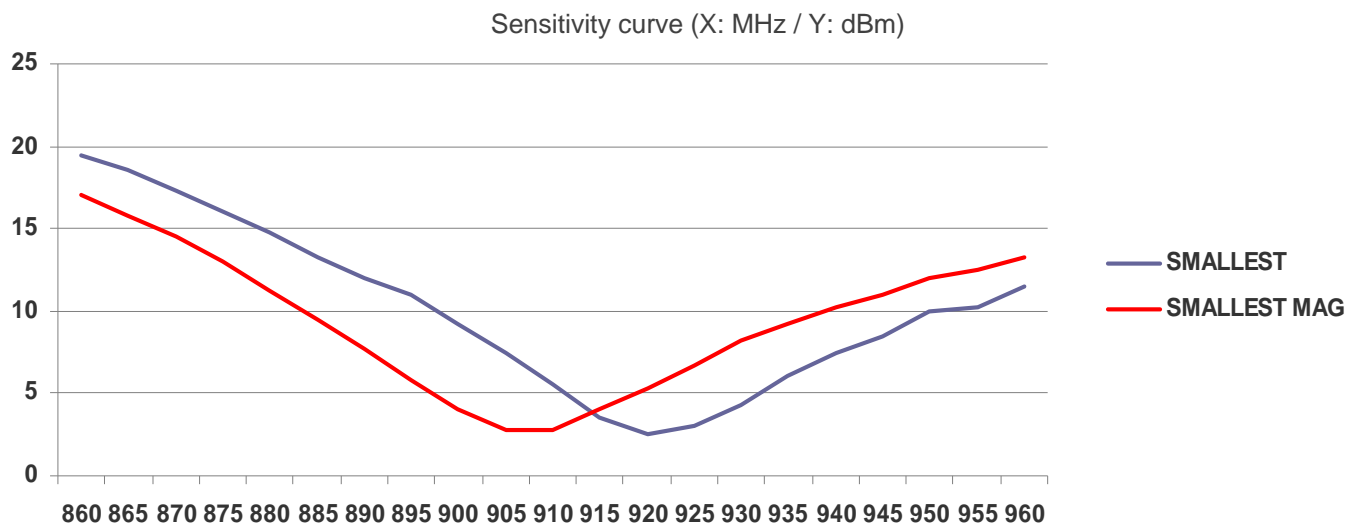
- Per each SMALLEST MAG, two magnet discs with size of 7.0mm diameter and 1.5mm thickness are embedded on backside of SMALLEST, covered with 1.0mm thick aluminum strip.
- For magnet materials, SMALLEST MAG adopt two kinds – Neodymium magnet (ND) and Samarium Cobalt magnet (SMCO).
- ND's magnetic energy property is highest among permanent magnets and its mechanical hardness and property is also excellent, however it can withstand only up to 80°C.
- SMCO's magnetic energy property is roughly 90% of ND and can withstand up to 220°C. However, it is weak and brittle, and its price is three times higher than ND's.
- SMALLEST MAG is embedded with ND#35 and SMCO#26, which are most common magnet series in each ND and SMCO. For further information on ND and SMCO, please contact RFcamp.
- RFcamp strongly recommends that users apply SMALLST MAG under environments < 80°C with ND magnet discs embedded. And users must be very cautious on using SMCO magnets due to its fragilities.
- Here below is basic property of ND#35. For further information on ND#35, please contact RFcamp.

Residual Flux Density	Coercive Force	Intrinsic Coercive Force	Max. Energy Product
11.7-12.1 KGs	>11.0 KOe	>12 KOe	33-35 MGOe
Thermal Expansion Coefficient	Max. Operating Temp.	Curie Temp.	Thermal Conductivity
-0.12%/°C	80°C	310°C	7.7 kcal/m-h-°C

2. About tag read performance

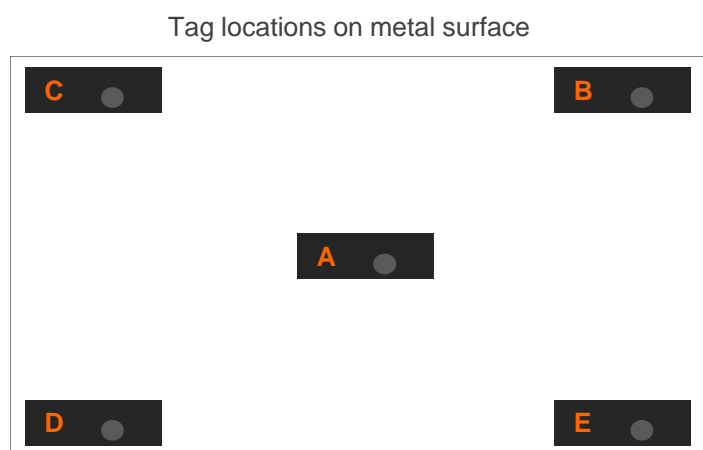
2-1. Main features (compared with other Titan tags)

- SMALLEST MAG is derivative product from SMALLEST, with same width and height, and it performs almost same as SMALLEST.
- Here below graph shows sensitivity curve comparison among SMALLEST MAG and SMALLEST – All US version. As can be seen, SMALLEST MAG shows almost same sensitivity curve as does SMALLEST, with curve shifted 15MHz down. For users, read range difference can hardly be recognized b/w SMALLEST and SMALLEST MAG.
- Therefore, with same size and similar performance, users can apply either of SMALLEST AND SMALLEST MAG wherever they want to.

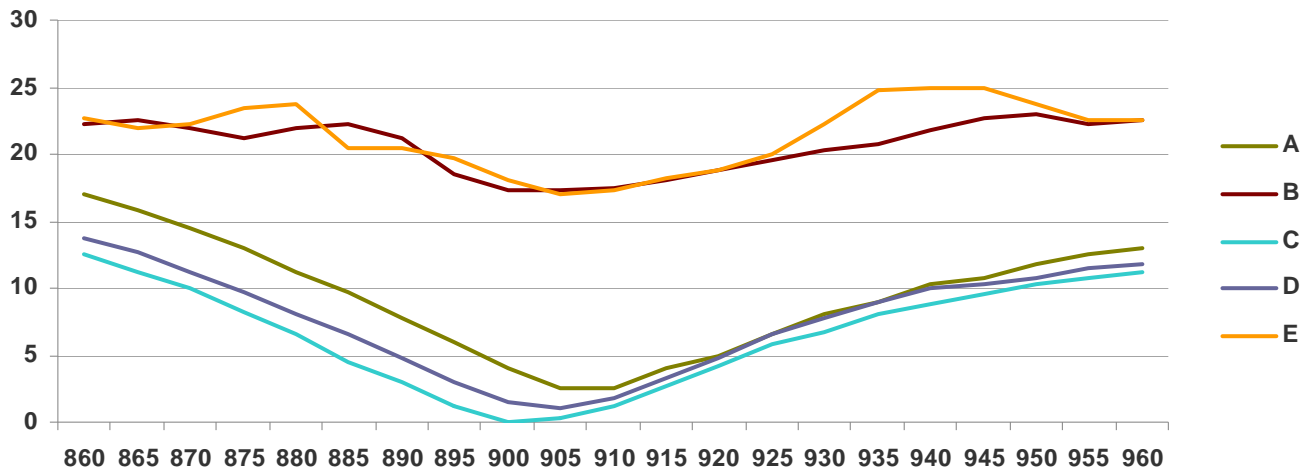


2-2. Tag location and read performance

- SMALLEST MAG'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. This result is also same as that of SMALLEST's.
- For further information, please contact RFcamp.

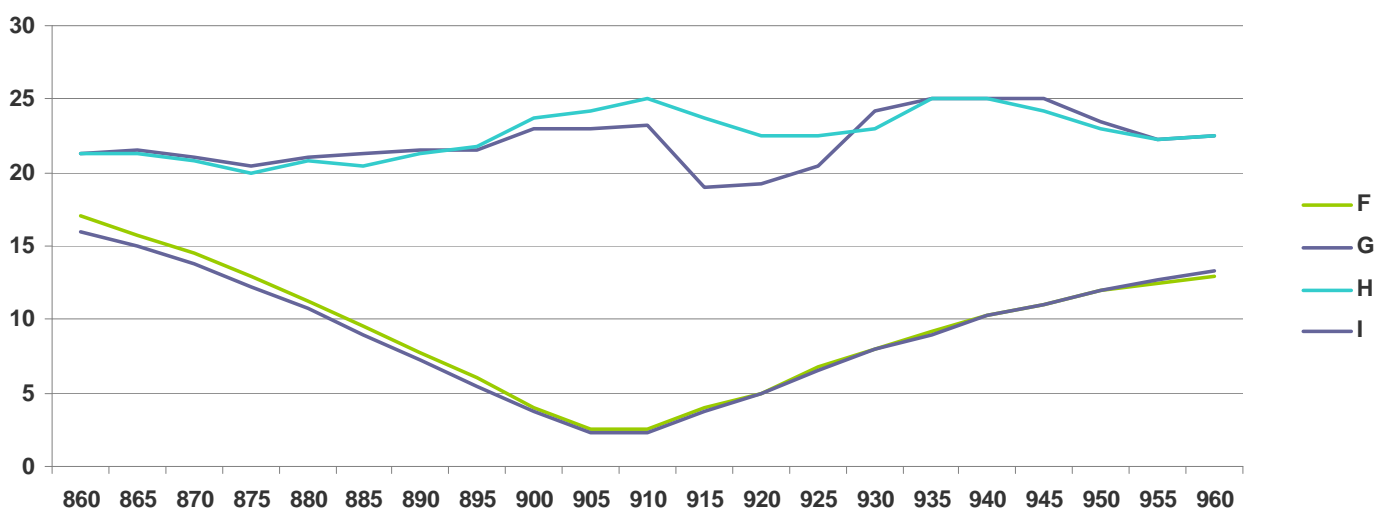
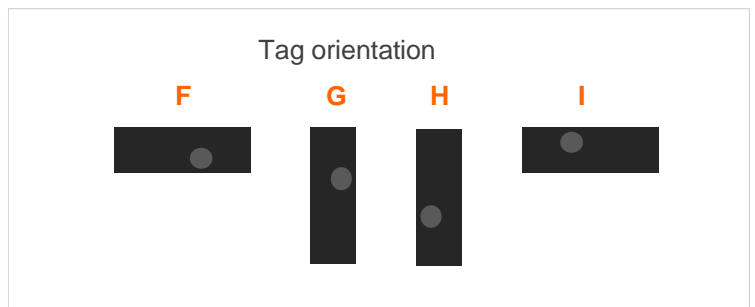


Sensitivity curve (Location)



2-3. Tag orientation and read performance

- With rectangular feature, SMALLEST MAG 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, same result as SMALLEST's.



2-4. 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#6, first paragraph of 2-4.

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.
- Storage and peak temperature for magnets – Neodymium vs. SMCO: Please see page#3, 1-6.

3-3. Water ingress

- 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 effectively 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.
- Mechanical stress and magnets: See page#3, 1-6. For further information, please contact RFcamp.

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.
- Chemical stress and magnets: See page#3, 1-6. For further information, please contact 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.