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### Co-existence of LF & UHF in dual-technology tags

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1. ScotEID is currently conducting field trials of bovine electronic identification (EID) using dual-technology ear tags embodying both Low Frequency (LF) and Ultra High Frequency (UHF) transponders. Concerns have been raised about the possibility of interactions between the two technologies somehow compromising their individual performances. These concerns can be allayed in two ways.
2. First, LF (125 – 134 kHz) and UHF (868 MHz) operate on completely separate parts of the radio frequency spectrum and basic physics means that they co-exist with no risk of interference between the different frequencies. Hence, as example analogies, LF tags and readers work alongside mobile phones (900 & 1800 MHz), televisions (470 to 850 MHz) and PA systems (863 – 865 MHz).
3. Second, performance can be influenced by the choice and physical arrangement of components within tags. For example, placing different transponder antennae in close proximity can affect their relative performance through “mutual coupling” - an electromagnetic phenomenon that can, depending on design configurations, be detrimental or (conversely) beneficial in some instances. However, published research on dual LF-UHF tags confirms that poor performance reflects poor design and that this can be overcome by the proper placement of components.<sup>1</sup>
4. Following an iterative design-and-test process drawing on practical experience, ScotEID varied the arrangement of components within dual LF-UHF tags to arrive at a preferred configuration. For example, rather than ‘stacking’ antenna horizontally on top of each other (an impracticality anyway in flat moulded ear tags), a ‘coplanar’ arrangement was adopted to place each antenna in the same geometrical plane but at different positions within the ear tag (see Figure 1). Volume production of the final design was commissioned from a commercial manufacturer, with several thousand tags now undergoing extensive field trials in beef and dairy cattle across Scotland.
5. Observations by ScotEID of dual-technology tags under both laboratory and field conditions have revealed no performance issues: both LF and UHF reading distances are as expected for each individual technology. This matches with the experiences of other international research teams currently exploring a variety of dual LF-UHF applications.<sup>2</sup> Hence concerns about dual LF-UHF tags somehow compromising performance are unfounded if appropriate design principles are followed.

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<sup>1</sup> e.g. Owen et al. (2009) On The Effect of Mutual Coupling on LF and UHF Tags Implemented in Dual Frequency RFID Applications. Antennas and Propagation Society International Symposium, 2009. APSURSI '09. IEEE

<sup>2</sup> e.g. pers comm DataMars, 2015

6. Indeed, more detailed ScotEID measurements under controlled conditions reveal a modest enhancement of the read ranges achieved for both LF and UHF within dual-tags relative to single-technology tags (see Tables 1 and 2). This confirms that combining the two technologies through careful design has not only avoided impairing performance but has actually enhanced it in some cases.

Figure 1: photograph of top and side views of a dual LF-UHF ear tag, showing antennae positions

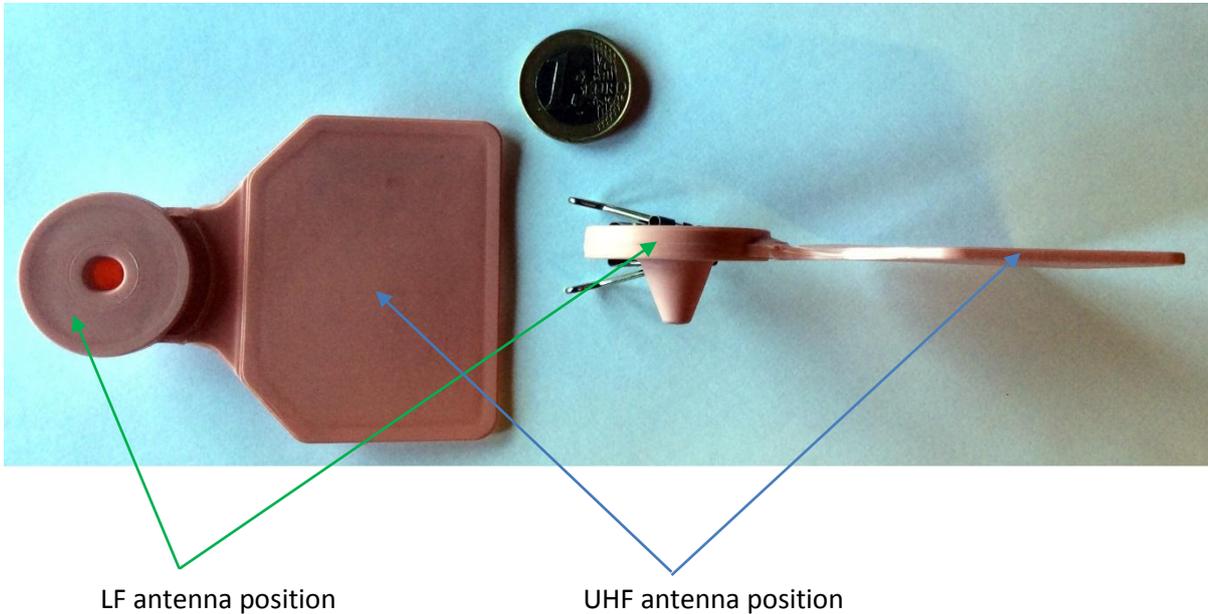


Table 1: comparative LF read ranges of LF-only and dual LF-UHF tags<sup>3</sup>

Test on LF Read Ranges							
TAG	LF Transponder	UHF Transponder	No of Tags Tested	LF Reader only TX		Both UHF and LF Readers TX Simultaneously	
Tag Orientation				Side	Vertical	Side	Vertical
Allflex LF (OS)	HDX	None	20	21cm	67cm	21cm	68cm
Allflex LF/UHF (OS)	HDX	Smartrac 296_2	20	22cm	69cm	22cm	69cm
ZeeTag LF	FDX	None	20	21cm	67cm	21cm	68cm
ZeeTag LF/UHF	FDX	Alien ALN 9728GT	20	22cm	68cm	22cm	68cm

Table 2: comparative UHF read ranges of UHF-only and dual LF-UHF tags<sup>3</sup>

Test on UHF Read Ranges		
UHF Transponder Type	Tag Type	Av' Metres
UMP Web 296_1	Zee Tag - UHF only	4.80
UMP Web 296_1	Zee Tag - UHF & LF	5.37

<sup>3</sup> Holding all other factors constant, notably type and configuration of reader. For example, UHF results were recorded using a Deister UDL 500 @ 2 Watts ERP.