TECHNICAL REPORT

ISO/IEC TR 18268

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Identification cards — Contactless integrated circuit cards — Proximity cards — Multiple PICCs in a single PCD field

Cartes d'identification — Cartes à circuit(s) intégré(s) sans contact — Cartes de proximité — Multiples PICCs dans le champ d'un seul PCD

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Foreword

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

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ISO/IEC TR 18268 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

Introduction

Experience from the field has shown that the presence of multiple PICCs in a field can have unexpected results in terms of all PICCs being seen by the PCD and the quality of the communications. This Technical Report seeks to assemble the collective knowledge of the engineering principles involved.

This Technical Report is relevant to the standards listed in the Bibliography and an understanding of these is useful in placing this Technical Report in context.

Identification cards — Contactless integrated circuit cards — Proximity cards — Multiple PICCs in a single PCD field

1 Scope

This Technical Report presents a collation of industry experience of technical issues resulting from the presence of multiple PICCs in the field of a PCD. It describes how resonance frequencies may shift, how individual PICCs may see a reduced field strength, how multiple PICCs load the PCD, how they may change the local modulation signal and how PICCs should manage their identities to aid support of simultaneous usage. Scenarios for electronic passports with multiple visas and wallets containing multi-industry cards are explored.

2 Symbols and abbreviated terms

f_r	resonant frequency
H_{low}	lowest magnetic field strength
Q	quality factor
PCD	proximity coupling device
PICC	proximity card or object

3 General

In order that multiple PICCs can be reliably presented to a PCD, the following should generally be achieved:

a) PICCs presented (within the PCD's operating field) need to receive sufficient power to operate.

b) The communications interface between each PICC and the PCD needs to operate reliably (for all PICCs within the PCD operating field).

c) The PCD should perform its intended functionality in a manner such that the cardholder experience is reliable and consistent.

In an operational contactless interface, there are a number of components that have a mutual interaction. The most dominant of these is the inductive coupling between the coil of the PCD antenna and that of the PICC, plus further interaction between all the PICC antennas if there are multiple PICCs within the field. The interaction is multi-faceted and depends on the coupling factor k between each inductance, the resonant frequency f_r of the individual PICCs and the quality factor Q of all of the inductive components. Other factors which also have an impact are the size of antenna, separation distance, spatial overlap, PICC loading and the dynamic movement of PICCs through the PCD field.

With so many degrees of freedom, it is not possible to describe the definitive outcome for any particular combination of PICCs presented to an individual PCD. However, it is possible to quantify certain aspects with the objective of gaining an improved understanding of the mechanisms involved. This is expected to lead to recommendations and potential revisions to the standards that will ultimately improve the acceptance of multiple PICCs presented to a single PCD. The main items that can be addressed are:

— the PICC interaction such that the resulting resonant frequency of the set of PICCs is lower compared to the resonant frequency of an individual PICC;

— the uneven sharing of power between the PICCs in the field, such that some may receive insufficient power to operate correctly;

— the influence on PCD modulation caused by close coupled PICCs, such that collectively, multiple PICCs in the field will receive a modified modulation signal shape.

In order that contactless products continue to have practical application, the reliability and consistency of the user experience needs to be addressed in the following areas:

— The PCD should be able to reliably build a list of applications available on the presented PICCs and determine in a consistent manner an order for which it will attempt to undertake its intended function.

— This process should be easy to understand by the general public and consistent across PCDs such that the user feels in control.

— The user interface on the PCD should provide simple feedback to the user, such that they understand when the intended function is completed, or if an issue has occurred.

— Overall performance (speed of operation) should not be reduced significantly when multiple PICCs are presented such that the usability of the functionality is compromised.

4 Physical effects of multiple PICCs

4.1 Resonant frequency

When operating within an electro-magnetic field of given frequency, then maximum power coupling would occur if PICCs are tuned to have a resonant frequency equal to the operating frequency of the field. However, typical PICCs are manufactured to have a resonant frequency higher than the operating frequency (13,56 MHz) to limit the loading effect on PCDs.

When the antenna of a PICC is close to another antenna there will be a drop in its resonant frequency (f_r). This is due to the capacitive coupling and mutual inductance that forms between the turns of the coils of the two antennas. From the formula $f_r = 1/(2\pi\sqrt{LC})$, if either the capacitance or inductance increases, then the frequency will drop. Both the antenna in the PCD and the antennas of other PICCs in the field will cause this effect. Generally the coupling to a physically adjacent PICC (or PICCs) will be more than that to the PCD antenna.

Figure 1 and Figure 2 show this effect as evaluated experimentally for ISO/IEC 14443 operation using multiple PICCs all having an individual resonance frequency of about 20 MHz.

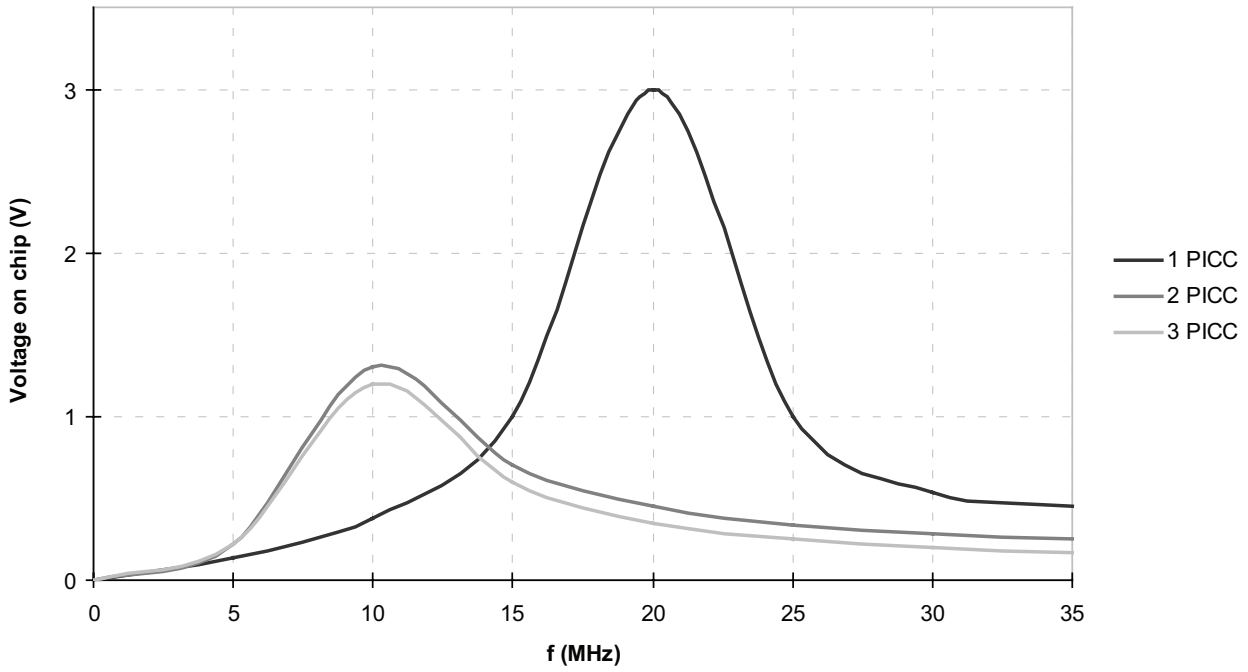

Figure 1 — Power drop and resonance shift

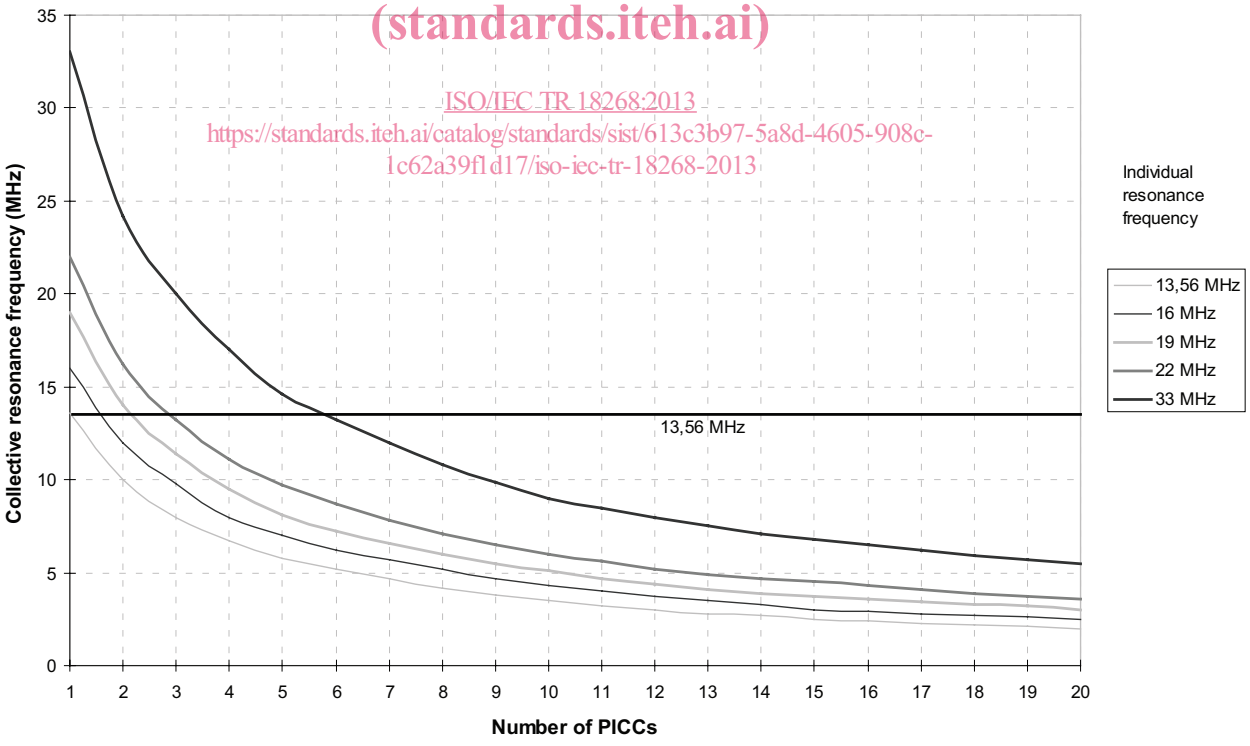

Figure 2 — Collective resonance frequency vs number of PICCs