INTERNATIONAL STANDARD

# ISO/IEC 22536

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# Information technology — Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol (NFCIP-1) — RF interface test methods

*Technologies de l'information — Télécommunications et échange d'information entre systèmes — Interface et protocole de communication en champ proche (NFCIP-1) — Méthodes d'essai pour interface RF*



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## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 22536 was prepared by Ecma International (as ECMA-356) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in parallel with its approval by national bodies of ISO and IEC.

# Information technology — Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol (NFCIP-1) — RF interface test methods

## 1 Scope

This International Standard is part of a suite of standards that specify tests for ISO/IEC 18092. It defines test methods for the RF-interface. This International Standard specifies RF-test methods for NFC devices with antennas fitting within the rectangular area of 85 mm by 54 mm.

This test standard, the first of two parts, specifies compliance tests for the RF interface of ISO/IEC 18092 devices. The companion test standard specifies protocol tests for ISO/IEC 18092.

Ecma purposefully aligned this International Standard with ISO/IEC 10373-6 to allow testing laboratories to reuse equipment and expertise.

## 2 Conformance

A system implementing ISO/IEC 18092 is in conformance with this International Standard if it meets all the mandatory requirements specified herein.

## 3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18092:2004, *Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)*

## 4 Conventions and notations

### 4.1 Representation of numbers

The following conventions and notations apply in this document unless otherwise stated.

— Letters and digits in parentheses represent numbers in hexadecimal notation.

— The value of a bit is denoted by ZERO or ONE.

— Numbers in binary notation and bit patterns are represented by strings of digits 0 and 1 shown with the most significant bit to the left. Within such strings, X may be used to indicate that the value of a bit is not specified within the string.

### 4.2 Names

The names of basic elements, e.g. specific fields, are written with a capital initial letter.

### 4.3 Test report

The test report Includes the number of passed tests versus the total number of tests, the number of different samples and the date of the tests, see Annex D.

## 5 Abbreviations and acronyms

| | |
|---|---|
| ar | Reference device width |
| br | Reference device height |
| ch | Calibration coil height |
| cw | Calibration coil width |
| cr | Calibration coil corner radius |
| dis | Distance between field generating antenna and sense coils |
| DFT | Discrete Fourier Transformation |
| DUT | Device under test |
| fc | Frequency of the operating field |
| fs | Frequency of subcarrier at 106 kbit/s in passive communication mode |
| $H_{max}$ | Maximum field strength of the Initiator antenna field |
| $H_{min}$ | Minimum field strength of the Initiator antenna field |
| $H_{Threshold}$ | Minimum field strength for the RF level detector |
| $L_{Calcoil}$ | Inductance of the calibration coil |
| $L_{Refcoil}$ | Inductance of the reference device |
| lx | Length of test assembly connection cable |
| lya | Field generating and sense coil PCB width |
| lyb | Field generating and sense coil PCB height |
| lyd | Field generating coil diameter |
| lyw | Field generating coil track width |
| NFC | Near Field Communication |
| nr | Number of turns of reference device |
| oh | Calibration coil outline height |
| ow | Calibration coil outline width |
| PCB | Printed Circuit Board |
| RF | Radio Frequency |
| $R_{Calcoil}$ | Resistance of the calibration coil |
| $R_{Refcoil}$ | Resistance of the reference device |
| rs | Sense coil corner radius |
| sa | Sense coil width |

| | |
|---|---|
| sb | Sense coil height |
| sr | Reference device track spacing |
| wr | Reference device track width |

# 6 Default items applicable to the test methods

## 6.1 Test environment

Unless otherwise specified, testing shall take place in an environment of temperature 23°C ± 3°C (73°F ± 5°F) and of relative humidity 40 % to 60 %.

## 6.2 Default tolerance

Unless otherwise specified, a tolerance of ± 5 % shall be applied to the values given to specify the characteristics of the test equipment (e.g. linear dimensions) and the test method procedures (e.g. test equipment adjustments).

## 6.3 Spurious Inductance

Resistors and capacitors shall have negligible inductance.

## 6.4 Total measurement uncertainty

The measurement uncertainty shall be recorded.

NOTE Basic information is given in “ISO Guide to the Expression of Uncertainty in Measurement“, ISBN 92-67-10188-9, 1993.

# 7 Test Set-up and test circuits

The test set-up includes:

- Calibration coil
- Test assembly
- Reference devices
- Digital sampling oscilloscope

These are described in the following clauses.

This test set-up applies to NFCIP-1 devices with antennas fitting within the rectangular area of 85 mm by 54 mm.

## 7.1 Calibration coil

This clause defines the size, thickness and other characteristics of the calibration coil.

### 7.1.1 Size of the calibration coil

The calibration coil shall be integrated in a PCB that consists of an area, which has the height and width defined in Table 1 containing a single turn coil concentric with the calibration coil outline. Figure 1 illustrates the calibration coil.

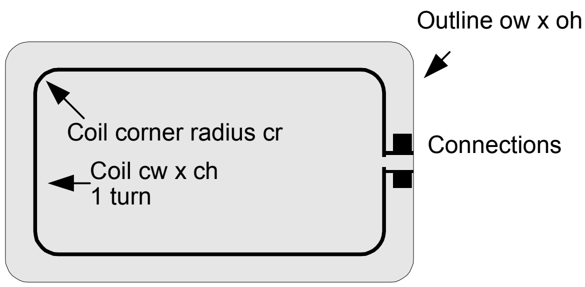



**Figure 1 — Calibration coil**

### 7.1.2 Thickness and material of the calibration coil PCB

The thickness of the calibration coil PCB shall be 0,76 mm ±10 %. It shall be constructed of a suitable insulating material.

### 7.1.3 Coil characteristics

The coil shall have one turn. The outer size of the coil shall have a corner radius cr as defined in Table 1.

The coil is made as a printed coil on a PCB plated with 35 µm copper. Track width shall be 500 µm ± 20 %. The size of the connection pads shall be 1,5 mm by 1,5 mm.

**Table 1 — Definition of calibration coil**

| Name | Symbol | Value |
|---|---|---|
| Outline width | ow | 85 mm (+/-2 %) |
| Outline height | oh | 54 mm (+/-2 %) |
| Coil width | cw | 72 mm (+/-2 %) |
| Coil height | ch | 42 mm (+/-2 %) |
| Coil corner radius | cr | 5 mm (+/-2 %) |

NOTE At 13,56 MHz the approximate inductance $L_{Calcoil}$ is 250 nH and the approximate resistance is $R_{Calcoil}$ 0,4 Ohm.

A high impedance oscilloscope probe (e.g. >1 MOhm, <14 pF) shall be used to measure the (open circuit) voltage in the coil. The resonant frequency of the whole set (calibration coil, connecting leads and probe) shall be above 60 MHz.

The open circuit calibration factor for this coil is 0,32 Volts (rms) per A/m (rms) [Equivalent to 900 mV (peak-to-peak) per A/m (rms)].

NOTE A parasitic capacitance of the probe assembly of less than 35 pF normally ensures a resonant frequency for the whole set of greater than 60 MHz.

NOTE The high impedance oscilloscope probe ground connection should be as short as possible, less than 20 mm or alternatively use a coaxial connection.

## 7.2 Test assembly

The test assembly for load modulation consists of a field generating antenna and two parallel sense coils: sense coil a and sense coil b. The test assembly set-up is shown in Figure 2. The sense coils are connected such that the signal from one coil is in opposite phase to the other. The potentiometer P1 serves to fine adjust the balance point when the sense coils are not loaded by a Target or any magnetically coupled circuit. The capacitive load of the probe including its parasitic capacitance shall be less than 14 pF.

NOTE The capacitance of the connections and oscilloscope probe should be kept to a minimum for reproducibility.

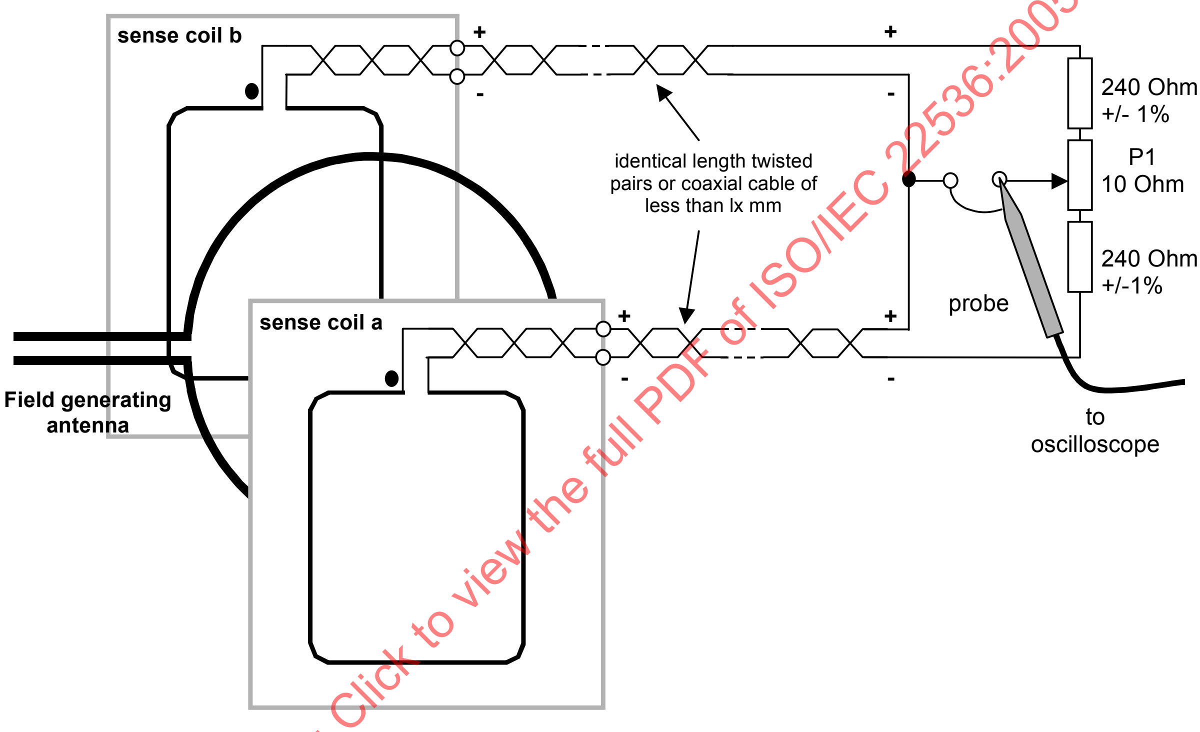



Figure 2 — Test assembly set-up (principle)



NOTE In order to avoid any unintended misalignment in case of an unsymmetrical set-up, the tuning range of the potentiometer P1 is only 10 Ohms. If the set-up cannot be compensated by the potentiometer P1 the symmetry of the set-up should be checked.

NOTE The high impedance oscilloscope probe ground connection should be as short as possible, less than 20 mm or alternatively use a coaxial connection.

### 7.2.1 Field generating antenna

The field generating antenna shall have a diameter and a construction as specified in Annex A. To match the impedance of the antenna to the antenna output driver a matching circuit as defined in Annex A2 shall be used. The antenna shall be tuned to 50 Ohm by the matching circuit using suitable measurement equipment such as an impedance analyser or a measurement bridge.

### 7.2.2 Sense coils

The size and the sense coil layout and assembly are specified in Annex B.

### 7.2.3 Arrangement of the test assembly

The sense coils and field generating antenna are assembled parallel and with the sense and antenna coils coaxial and such that the distance between the active conductors has the value dis in Table 2. The distance between the coil in the DUT and the calibration coil shall be equal with respect to the coil of the field generating antenna. There shall be a 3 mm air space between the DUT and sense coil a in order to avoid parasitic effects such as detuning by closer spacing or ambiguous results due to noise and other environmental effects. The antenna of the DUT shall be placed in parallel to the sense coils.

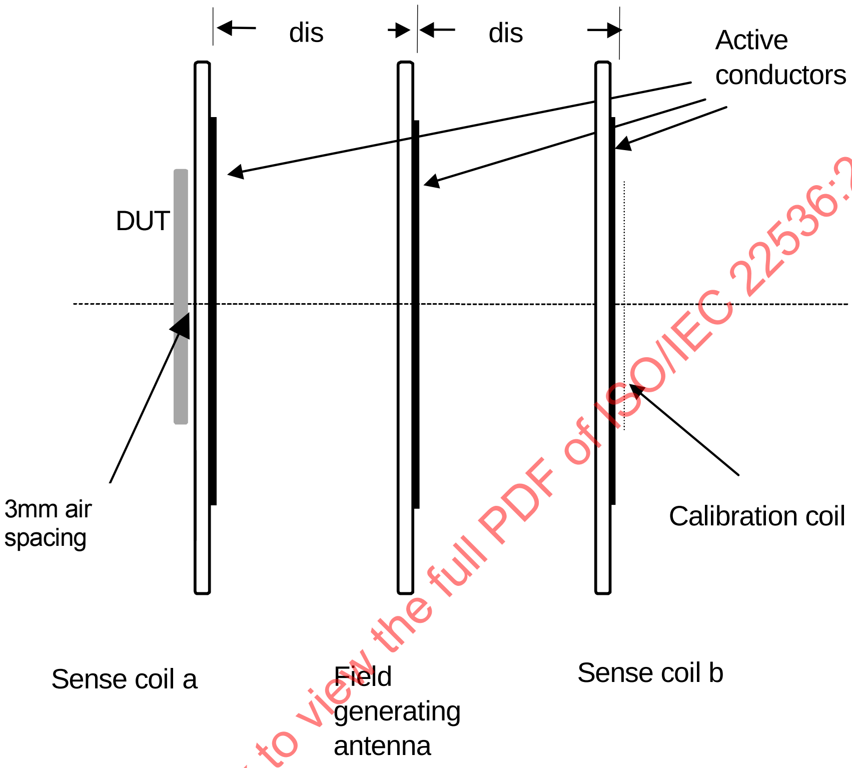



**Figure 3 — Test assembly**



**Table 2 — Definition of test assembly**

| Name | Symbol | Value |
|---|---|---|
| Distance | dis | 37,5 mm |
| Sense coil connection cable length (max.) | lx | 100 mm |

## 7.3 Reference devices

Reference devices are used to measure:

— The Initiator power: to verify that the Initiator generates a field with a field strength within the range of $H_{min}$ and $H_{max}$ (under conditions of loading by a Target).

— The load modulation: to verify that the Target exerts at least the minimum load modulation.

### 7.3.1 Initiator power

The schematic for the Initiator power test is shown in Annex C. Power dissipation can be set by resistor R1 or R2 respectively in order to measure $H_{max}$ and $H_{min}$. The resonant frequency can be adjusted with C2.

### 7.3.2 Load modulation

A schematic for the load modulation test is shown in Annex E. This reference device is calibrated by using the test assembly as follows:
The reference device is placed in the position of the DUT. The load modulation signal amplitude is measured as described in 8.2. This amplitude shall be the minimum amplitude at all values of field strength required by ISO/IEC 18092.

### 7.3.3 Dimensions of the reference device

Figure 4 illustrates a reference device with coil outline dimensions of 85 by 54 mm and a test circuit, which emulates the required Target functions. The schematics of the circuits are described in Annex C and Annex E. These circuits shall be connected to the coil in such a way that it can be inserted into the test assembly without causing interference to the test.

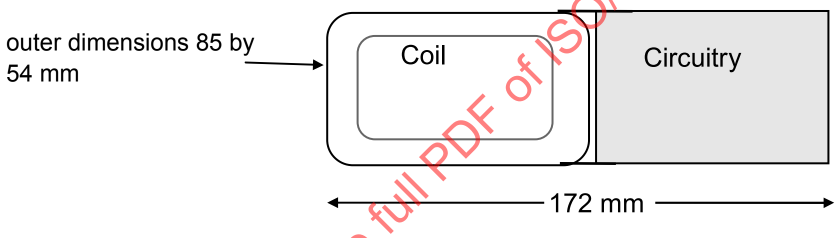



**Figure 4 — Reference device**



### 7.3.4 Thickness of the reference device PCB

The thickness of the reference device PCB shall be 0,76 mm ± 10 %.

### 7.3.5 Coil characteristics

The coil of the reference device shall have nr turns and shall be concentric with the area outline.

The outer size of the coil shall be ar by br.

The coil is printed on PCB plated with 35 µm copper.

The coil width shall be wr and spacing shall be sr.

**Table 3 — Reference device for Initiator power test and load modulation test**

| Name | Symbol | Value |
|---|---|---|
| Number of turns | nr | 4 |
| Coil outline width | ar | 72 mm (± 2 %) |
| Coil outline height | br | 42 mm (± 2 %) |
| Track width | wr | 500 µm (± 20 %) |
| Track spacing | sr | 500 µm (± 20 %) |

NOTE At 13,56 MHz the nominal inductance $L_{Refcoil}$ is 3,5 µH and the nominal resistance $R_{Refcoil}$ is 1 Ohm.

## 7.4 Digital sampling oscilloscope

The digital sampling oscilloscope shall be capable of sampling at a rate of at least 100 million samples per second with a resolution of at least 8 bits at optimum scaling.

NOTE The oscilloscope should have the capability to output the sampled data as a text file to facilitate mathematical and other operations such as windowing on the sampled data using external software programmes (Annex F).

# 8 Functional Test – Target

## 8.1 Target RF Level Detection

### 8.1.1 Purpose

The purpose of this test is to verify that the NFCIP-1 device detects an external RF field with a fieldstrength in the range of $H_{Threshold}$ up to $H_{max}$.

### 8.1.2 Test procedure

The test circuit of Figure 2 and the test assembly of Figure 3 are used.

Step 1:

The RF power delivered by the signal generator to the field generating antenna shall be adjusted to the required field strength in the range of 0 up to $H_{max}$ as measured by the calibration coil without any Target.

The output of the test circuit of Figure 2 is connected to a digital sampling oscilloscope. The potentiometer P1 shall be trimmed to minimise the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shorting one sense coil so that it can be used to detect if the DUT switches on the RF field.

Step 2:

The NFC device under test shall be placed in the DUT position, concentric with sense coil a. The DUT shall be set into Initiator mode.

The signal generator shall start to generate a non-modulated RF-field at the frequency $f_c$. The field strength shall be increased linear in the range from 0 up to $H_{max}$. $H_{max}$ is the maximum field strength without any Target.

The test shall verify if the Initiator correctly switches on its RF-field:

- If the field strength is below $H_{Threshold}$ the Initiator switches on its own RF-field.
- For field strength equal or higher than $H_{Threshold}$ the Initiator does not switch on its own RF- field.

### 8.1.3 Test report

The test report shall indicate whether the DUT behaves correctly according to the procedure described in 8.1.2.



## 8.2 Target passive Communication mode

### 8.2.1 Purpose

The purpose of these tests is to determine the amplitude of the Target's load modulation signal while varying the field strength in the range of $H_{min}$ and $H_{max}$ as defined in the test procedure in 8.2.2.

### 8.2.2 Test procedure

ISO/IEC 18092 specifies 3 different data rates for the passive communication mode. The test for the Target in the passive communication mode shall be performed at 106 kbit/s, 212 kbit/s and 424 kbit/s.

#### 8.2.2.1 Test procedure for 106 kbit/s

The load modulation test circuit of Figure 2 and the test assembly of Figure 3 are used.

Step 1:

The RF power delivered by the signal generator to the field generating antenna shall be adjusted to the required field strength and modulation waveforms as measured by the calibration coil without any Target.

The output of the load modulation test circuit of Figure 2 is connected to a digital sampling oscilloscope. The potentiometer P1 shall be set to minimise the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shorting one sense coil.

Step 2:

The Target under test shall be placed in the DUT position, concentric with sense coil a. A SENS_REQ command sequence as defined in ISO/IEC 18092 shall be sent to the DUT to obtain a SENS_RES response.

NOTE Care should be taken to apply a proper synchronization method for low amplitude load modulation.

Exactly two subcarrier cycles of the sampled modulation waveform shall be Fourier transformed. A discrete Fourier transformation with a scaling such that a pure sinusoidal signal results in its peak magnitude shall be used. To minimize transient effects, a subcarrier cycle immediately following a non-modulating period must be avoided.

The amplitudes of the upper sideband at *fc+fs* and the lower sideband *fc-fs* and the applied fields and modulations shall be measured in this test.

#### 8.2.2.2 Test report at 106 kbit/s

If the amplitudes of the upper sideband *fc+fs* and the lower sideband *fc-fs* respectively are above the values specified in ISO/IEC 18092 then this test passes.

#### 8.2.2.3 Test procedure for 212 kbit/s and 424 kbit/s

The load modulation test circuit of Figure 2 and the test assembly of Figure 3 are used.

Step 1:

The RF power delivered by the signal generator to the field generating antenna shall be adjusted to the required field strength and modulation waveforms as measured by the calibration coil without any Target.

The output of the load modulation test circuit of Figure 2 is connected to a digital sampling oscilloscope. The potentiometer P1 shall be set to minimise the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shorting one sense coil.

Step 2:

The Target under test shall be placed in the DUT position, concentric with sense coil a.

A Polling Request command sequence as defined in ISO/IEC 18092 shall be sent to the DUT to obtain a Polling Response. Only the preamble of the Target's response signal is used to perform the DFT.

NOTE Care should be taken to apply a proper synchronization method for low amplitude load modulation.

At least two data cycles of the sampled modulation waveform shall be Fourier transformed. A discrete Fourier transformation with a scaling such that a pure sinusoidal signal results in its peak magnitude shall be used. To minimize transient effects, a modulated data cycle immediately following a non-modulating period must be avoided.

The amplitudes of modulated data shall be measured in this test at different field strengths applied.

#### 8.2.2.4 Test report at 212 kbit/s and 424 kbit/s

If the amplitudes of the modulated data are above the values specified in ISO/IEC 18092 then this test passes.

## 8.3 Target active Communication mode

### 8.3.1 Purpose

The purpose of these tests is to determine the amplitude of the Target's RF field and modulation signal while varying the field strength in the range of $H_{min}$ and $H_{max}$ as defined in the test procedure in 8.3.2.

### 8.3.2 Test procedure

ISO/IEC 18092 specifies 3 different data rates for the active communication mode.

The test for the Target in the active communication mode shall be performed at 106 kbit/s, 212 kbit/s and 424 kbit/s.

The test circuit of Figure 2 and the test assembly of Figure 3 are used.

Step 1:

The RF power delivered by the signal generator to the field generating antenna shall be adjusted to the required field strength and modulation waveforms in active communication mode at the selected data rate as measured by the calibration coil without any Target.

The output of the test assembly of Figure 2 is connected to a digital sampling oscilloscope. The potentiometer P1 shall be set to minimise the residual carrier. This signal shall be at least 40 dB lower than the signal obtained by shorting one sense coil.

Step 2:

The Target under test shall be placed in the DUT position, concentric with sense coil a. The ATR_REQ command sequence shall be sent to the DUT with field strengths $H_{min}$ and $H_{max}$ at all data rates to obtain the ATR_RES.

### 8.3.3 Test report

If the modulation index of the Target´s RF field, the timing of the RF field generation and the command sequence at all data rates and for $H_{min}$ and $H_{max}$ are according to ISO/IEC 18092 then these tests pass.



# 9 Functional Test – Initiator

## 9.1 Initiator field strength in active and passive Communication mode

### 9.1.1 Purpose

This test measures the field strength produced by an Initiator with its specified antenna in its operating volume as indicated by the manufacturer. The test procedure of 9.1.2 is also used to determine that the Initiator with its specified antenna generates a field not higher than the value $H_{max}$.

This test uses a reference device as defined in 7.3.1 to determine that a DUT is able to supply a field strength of at least $H_{min}$ to power the reference device placed anywhere within the defined operating volume.



### 9.1.2 Test procedure

Procedure for $H_{max}$ test:

1. Calibrate the test assembly to produce the $H_{max}$ operating condition on the calibration coil.

2. Tune the Reference device to 19 MHz.

NOTE The resonant frequency of the Reference device is measured by using an impedance analyser or a LCR-meter connected to a calibration coil. The coil of the Reference device should be placed on the calibration coil as close as possible, with the axes of the two coils being congruent. The resonant frequency is obtained when the resistive part of the measured complex impedance is at maximum.

3. Place the Reference device (see Annex C) into the DUT position on the test assembly. Set the jumper to R2 and adjust R2 to obtain $V_{DC}$ = 3 V (dc) measured with a high impedance voltmeter. Verify the operating field condition by measuring the voltage on the calibration coil as specified in 7.3.1.

4. Position the Reference device within the defined operating volume of the DUT. The voltage $V_{DC}$ measured with a high impedance voltmeter across R2 shall not exceed 3 V (dc).

Procedure for $H_{min}$ test:

1. Calibrate the test assembly to produce the $H_{min}$ operating condition on the calibration coil.

2. Tune the Reference device to 13,56 MHz.

3. Place the Reference device (see Annex C) into the DUT position on the test assembly. Set the jumper to R2 and adjust R2 to obtain $V_{DC}$ = 3 V (dc) measured with a high impedance voltmeter. Verify the operating field condition by monitoring the voltage on the calibration coil.

4. Position the Reference device within the defined operating volume of the DUT. The voltage $V_{DC}$ measured with a high impedance voltmeter across R2 shall exceed 3 V (dc).

### 9.1.3 Test report

The test report shall indicate whether the measured minimum and maximum field strength values are in the range of $H_{min}$ and $H_{max}$ while positioned within the operating volume of the DUT. The test report shall indicate the number of tested positions.

## 9.2 Initiator modulation index and waveform in active and passive Communication mode

### 9.2.1 Purpose

This test is used to determine the modulation index of the Initiator field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 18092 within the defined operating volume.

### 9.2.2 Test procedure

The calibration coil is positioned anywhere within the defined operating volume. The modulation index and waveform characteristics are determined from the induced voltage on the coil displayed on a suitable oscilloscope.

### 9.2.3 Test report

If the measured modulation index of the Initiator field, the rise and fall times and the overshoot values are according ISO/IEC 18092 within the defined operating volume, then these tests pass.

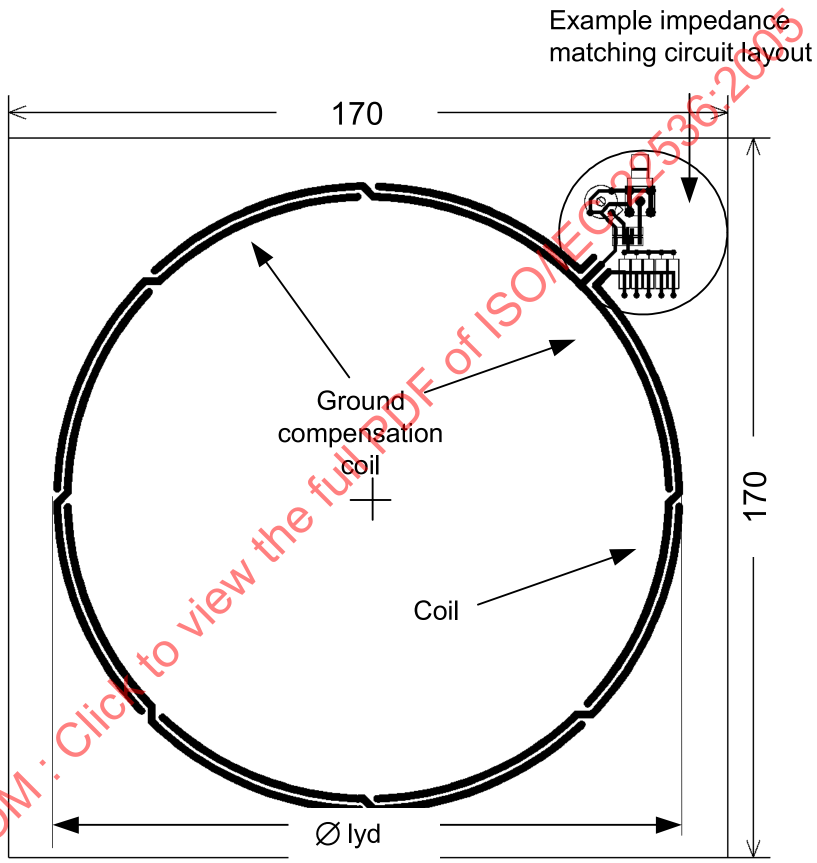
### 9.2.4 Initiator load modulation reception in passive Communication mode

Informative, see Annex E.

# Annex A
(normative)

# Field generating antenna

## A.1 Field generating antenna layout including impedance matching circuit






NOTE Drawings are not to scale.

The antenna coil track width is lyw (except for through-plated holes). Starting from the impedance matching circuit there are crossovers every 45°. PCB: FR4 material thickness 1,6 mm, double sided with 35 µm copper.

**Figure A.1 — Field generating antenna layout including impedance matching circuit (View from front)**

NOTE PCBs and/or finished Testsetups may be made available, for example, by:

| | |
|---|---|
| RFID Testlab | Phone: +43 (0) 50 550 - 6559 |
| arsenal research | Fax: +43 (0) 50 550 - 6660 |
| Faradaygasse | Email: mci@arsenal.ac.at |
| A-1030 Vienna | www.arsenal.ac.at/rfid |

**Table A.1 — Field generating antenna**

| Name | Symbol | Value |
|---|---|---|
| outline width | lya | 170 mm |
| outline height | lyb | 170 mm |
| coil diameter | lyd | 150 mm |
| coil track width | lyw | 1.8 mm |

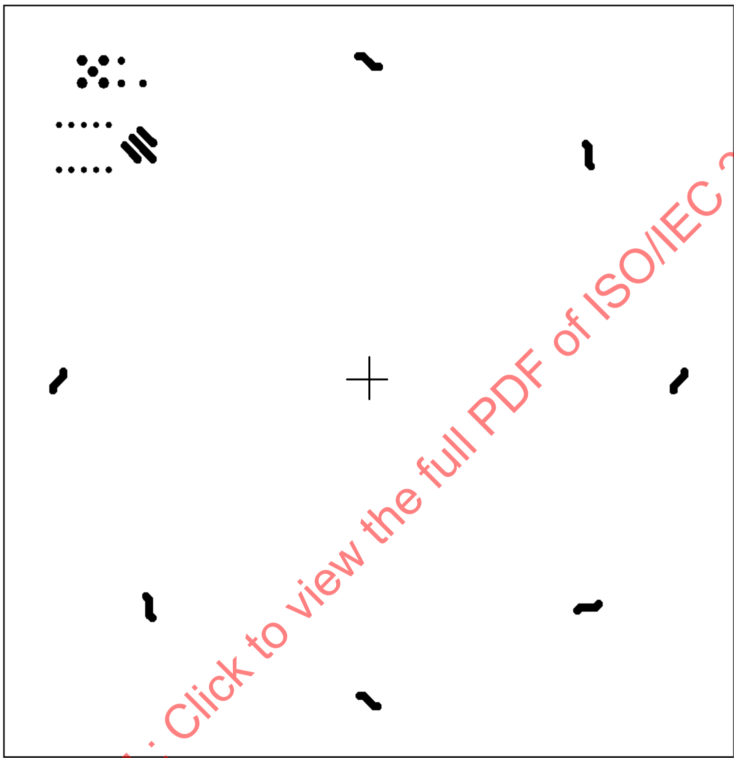


**Figure A.2 — Field generating antenna layout (View from back)**

## A.2 Impedance matching network

The antenna impedance ($R_{ant}$, $L_{ant}$) is adapted to the function generator output impedance (Z=50 Ohm) by a matching circuit (see below). The capacitors C1, C2 and C3 have fixed values. The input impedance phase can be adjusted with the variable capacitor C4.

The test assembly as defined in 7.2 and in this Annex is intended to be used for time limited measurements, to avoid any overheating of the individual components. If the test is run continuously, heat dissipation shall be improved.

NOTE If a heat sink is used $R_{ext}$ should be placed on the ground side of the antenna coil.

NOTE The linear low distortion variable output 50 Ohm power driver should be capable of emitting appropriate signal sequences. The modulation index should be adjustable in the ranges of 10 % - 30 % and 95 % - 100 %. The output power driver should be adjustable to deliver H fields as specified in ISO/IEC 18092. Care should be taken with fields above $H_{Max}$.

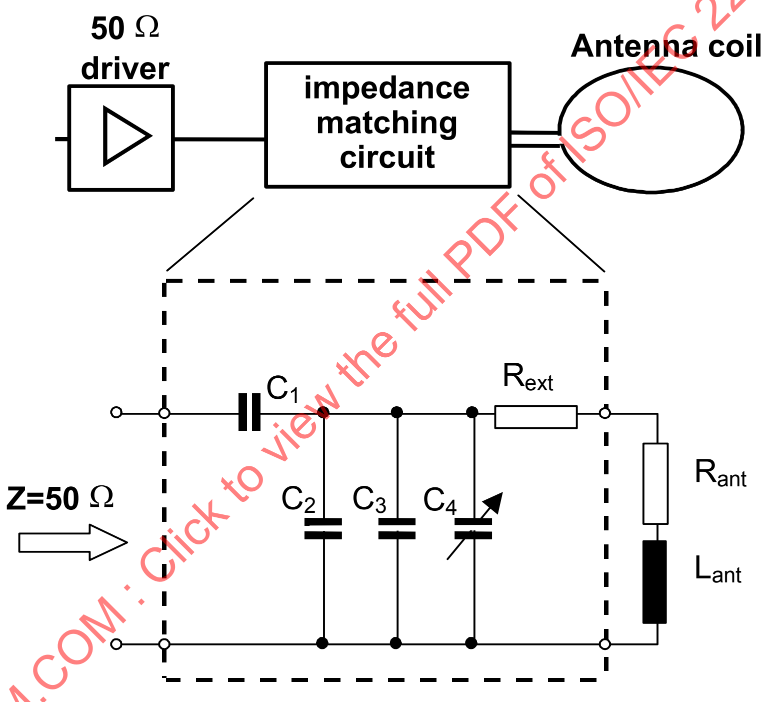





**Figure A.3 — Impedance matching circuit**

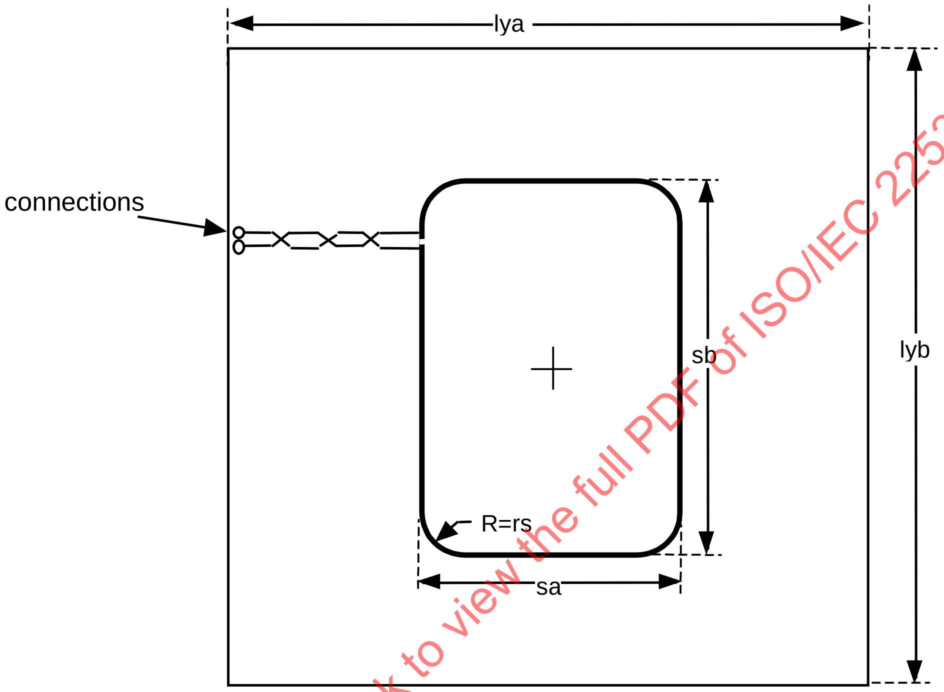
**Table A.2 — Impedance matching circuit components**

| Name | Symbol | Value | Remarks |
|---|---|---|---|
| Serial Matching Capacitor | C1 | 47 pF | Voltage Range 200V |
| Parallel Matching Capacitor | C2 | 180 pF | Voltage Range 200V |
| Parallel Matching Capacitor | C3 | 33 pF | Voltage Range 200V |
| Variable Capacitor | C4 | 2-27 pF | Voltage Range 200V |
| External Resistor | $R_{ext}$ | 5x4.7 (parallel) Ohm | 4 Watts at 7,5 A/m |

# Annex B
(normative)

# Sense coil

## B.1 Sense coil layout






NOTE Drawings are not to scale.

The sense coils width is 0,5 mm with relative tolerance ±20 % (except for through-plated holes). Sizes of the coils refer to the outer dimensions. PCB: FR4 material thickness 1,6 mm, double sided with 35 µm copper.

**Figure B.1 — Layout for sense coils a and b**

**Table B.1 — Sense coil**

| Name | Symbol | Value |
|---|---|---|
| Outline width | lya | 170 mm |
| Outline height | lyb | 170 mm |
| Sense coil width | sa | 70 mm |
| Sense coil height | sb | 100 mm |
| Coil corner Radius | rs | 10 mm |

## B.2 Sense coil assembly

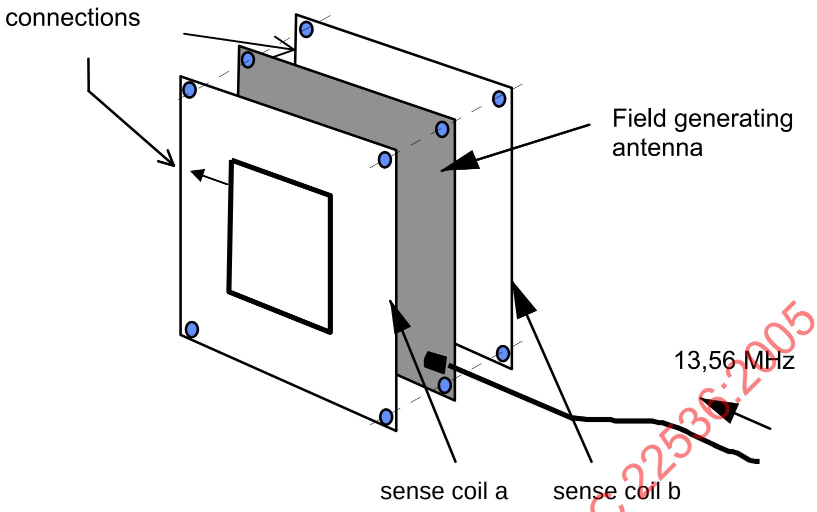



**Figure B.2 — Sense coil assembly**



# Annex C
(normative)

# Reference device for Initiator power test

## C.1 Circuit diagram for reference device

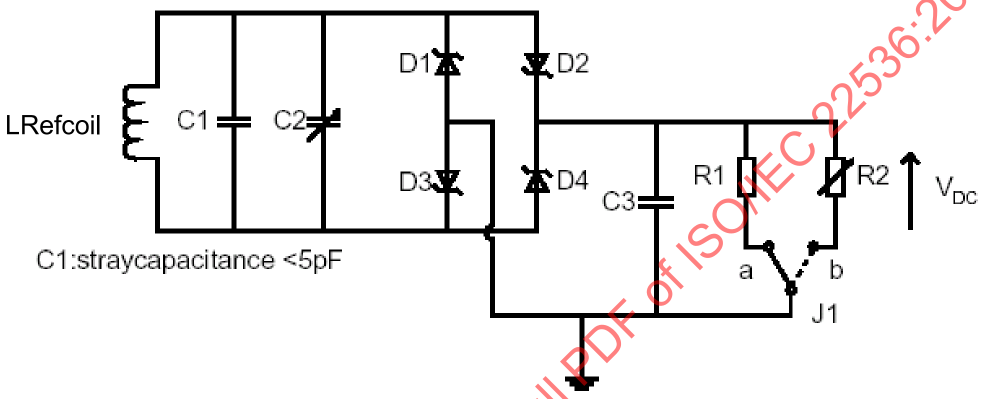



**Figure C.1 — Circuit diagram for reference device**

NOTE In order to limit the reverse voltage across the bridge rectifier at high field when the jumper J1 is removed or if the value of R1 or of R2 is not low enough to load the voltage at C3 sufficiently, a Zener diode (Value 15 Volts) should be added in parallel to C3.

**Table C.1 — Components list**

| Symbol | Value |
|---|---|
| LRefcoil | see 7.3.5. |
| C1 | Stray capacitance < 5 pF |
| C2 | 6…60 pF |
| C3 | 10 nF |
| D1, D2, D3, D4 | see characteristics in Table D.1 (BAR 43 or |
| R1 | 1,8 kOhm (5 mW) |
| R2 | 0-1 kOhm |

**Table C.2 — Specification of basic characteristics of D1, D2, D3, D4**

| Symbol | Test Condition at Tj=25 °C | Typ. | Max. | Unit |
|---|---|---|---|---|
| $V_F$ | $I_F$=2 mA | | 0,33 | V |
| C | $V_R$=1V,<br>f=1 MHz | 7 | | pF |
| $t_{rr}$ | $I_F$=10 mA,<br>$I_R$=10 mA,<br>$I_{rr}$=1 mA | | 5 | ns |

$V_F$ Forward voltage drop
$V_R$ Reverse voltage
$I_F$ Forward current
$I_R$ Reverse current
$t_{rr}$ Reverse recovery time
$I_{rr}$ Reverse recovery current
Tj Junction temperature
f Frequency
C Junction capacitance

# Annex D
(normative)

## Test report template

Supplier:

Product:

Legend:

# passed tests = number tests that have been successfully performed

# tests = total number of performed tests

# samples = number of different DUTs

# of tested positions = number of different positions in the operating volume



<table>
<tr><td colspan="7"></td></tr>
<tr><th>No</th><th colspan="2">Testname</th><th colspan="4">Purpose</th></tr>
<tr><td rowspan="4">8.1</td><td colspan="2">Target RF Level Detection</td><td colspan="4">The purpose of this test is to verify that the NFCIP-1 device detects an external RF field with a field strength in the range of $H_{Threshold}$ up to $H_{max}$.</td></tr>
<tr><th>Condition</th><th>Expected Result according ISO/IEC 18092</th><th># passed tests</th><th># tests</th><th># samples</th><th>Date</th></tr>
<tr><td>$H < H_{Threshold}$</td><td>DUT switch its RF field on</td><td></td><td></td><td></td><td></td></tr>
<tr><td>$H_{Threshold} =< H < H_{max}$</td><td>DUT does not switch its RF field on</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7"></td></tr>
<tr><th>No</th><th colspan="2">Testname</th><th colspan="4">Purpose</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Target passive Communication mode</td><td colspan="4">The purpose of these tests is to determine the amplitude of the Target's load modulation signal while varying the field strength in the range of $H_{min}$ and $H_{max}$.</td></tr>
<tr><th>Condition</th><th>Expected Result according ISO/IEC 18092</th><th># passed tests</th><th># tests</th><th># samples</th><th>Date</th></tr>
<tr><td></td><td>If the resulting amplitudes of the upper sideband fc+fs are above the values specified in ISO/IEC 18092 then this test passes.</td><td></td><td></td><td></td><td></td></tr>
</table>

| | | | | | | |
|---|---|---|---|---|---|---|
| 8.2 | 106 kbit/s | If the resulting amplitudes of the lower sideband fc-fs respectively are above the values specified in ISO/IEC 18092 then this test passes. | | | | |
| | 212 kbit/s | If the amplitudes of the modulated data are above the values specified in ISO/IEC 18092 then this test passes. | | | | |
| | 424 kbit/s | If the amplitudes of the modulated data are above the values specified in ISO/IEC 18092 then this test passes. | | | | |
| | | | | | | |
| **No** | **Testname** | | **Purpose** | | | |
| 8.3 | Target Active communication mode | | The purpose of these tests is to determine the amplitude of the Target's RF field and modulation signal while varying the field strength in the range of $H_{min}$ and $H_{max}$. | | | |
| | **Condition** | **Expected Result according ISO/IEC 18092** | **# passed tests** | **# tests** | **# samples** | **Date** |
| | $H_{min}$ 106 kbit/s | Modulation index | | | | |
| | | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | $H_{max}$ 106 kbit/s | Modulation index | | | | |
| | | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | $H_{min}$ 212 kbit/s | Modulation index | | | | |
| | | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | $H_{max}$ 212 kbit/s | Modulation index | | | | |
| | | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | $H_{min}$ 424 kbit/s | Modulation index | | | | |
| | | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | | Modulation index | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $H_{max}$<br>424 kbit/s | Timing of the RF field generation | | | | |
| | | Command sequence | | | | |
| | | | | | | |
| **No** | **Testname** | | **Purpose** | | | |
| 9.1 | Initiator field strength and power transfer in active and passive Communication mode. | | This test measures the field strength produced by an Initiator with its specified antenna in its operating volume as indicated by the manufacturer. | | | |
| | **Condition** | **Expected Result according ISO/IEC 18092** | **# passed tests** | **# tests & # of tested positions** | **# samples** | **Date** |
| | Different positions in the operating volume | $H_{min} < H < H_{max}$ | | | | |
| | | | | | | |
| **No** | **Testname** | | **Purpose** | | | |
| 9.2 | Initiator modulation index and waveform in active and passive Communication mode. | | This test is used to determine the modulation index of the Initiator field as well as the rise and fall times and the overshoot values as defined in ISO/IEC 18092 within the defined operating volume. | | | |
| | **Condition** | **Expected Result according ISO/IEC 18092** | **# passed tests** | **# tests & # of tested positions** | **# samples** | **Date** |
| | Different positions in the operating volume | Modulation index | | | | |
| | | Rise times | | | | |
| | | Fall times | | | | |
| | | Overshoot values | | | | |

# Annex E
(informative)

# Load modulation test

## E.1 Load modulation test

This test may be used to verify that an Initiator correctly detects the load modulation of a Target. It is supposed that the Initiator has means to indicate correct reception of the load modulation signal produced by a reference device.

The following clause describes a reference device and calibration procedure, which allows the sensitivity of an Initiator to load modulation to be assessed. This Reference device does not emulate the shunt action of all types of Targets, therefore it should be calibrated at a given field strength H in the Test Initiator assembly. The reference device should be placed in the Initiators field at a position where the field has the same value of the field strength *H*. The measurement of C3 (dc) voltage should be the same for both Reference device calibration and Initiator load modulation test.

## E.2 Reference device for load modulation test



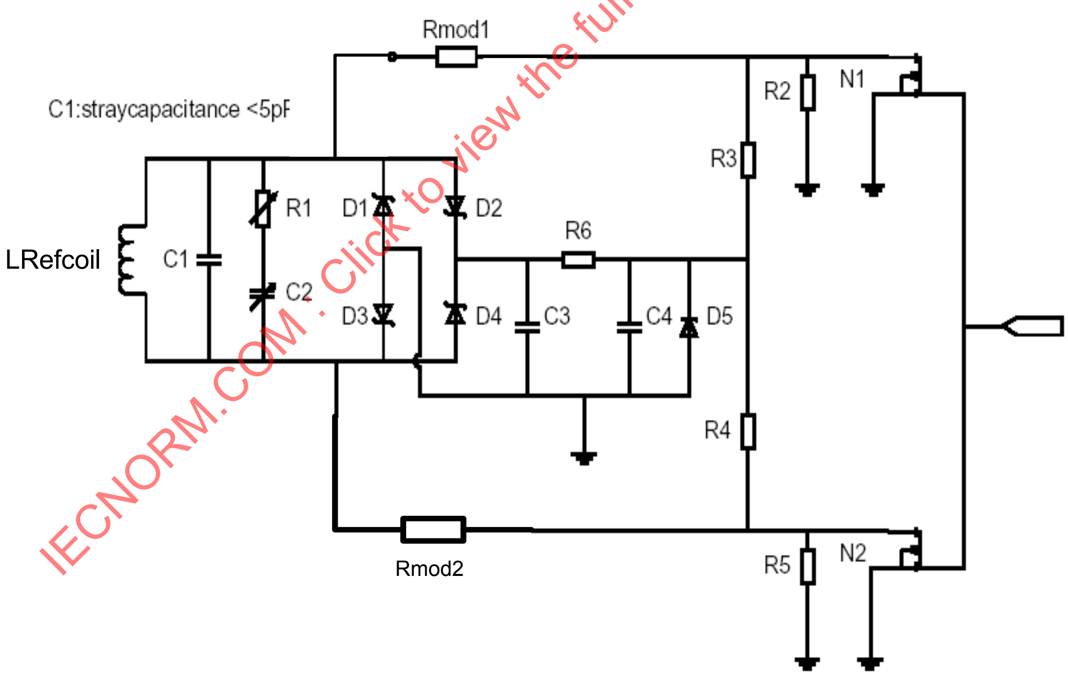



**Figure E.1 — Circuit diagram for Reference device for load modulation test**

Adjust following components for required emulation:

**Table E.1 — Adjustable components**

| Component | Function | Value |
|---|---|---|
| R1 | adjust Q | 0-10 Ohm |
| C2 | adjust resonant frequency | as required |
| Rmod1, Rmod2 | resistive modulation | between 400 Ohm and 12 kOhm |
| R6 | shunt current | between 10 Ohm and 5 kOhm |
| D5 | shunt voltage | between 2,7 V and 15 V |

**Table E.2 — Components list**

| Component | Value |
|---|---|
| R2, R3, R4, R5 | 1 Mohm |
| D1, D2, D3, D4 | as defined in Annex C, Table C.2 |
| LRefcoil | see 7.3.5 |
| C1 | Stray capacitance < 5 pF |
| C2 | 6-60 pF |
| C3 | 100 pF |
| C4 | 10 nF |
| N1, N2 | N-Mos transistor, 10 pF max output capacitance to ground |