14. Card Test Methods

This section specifies the PICC test methods specified with ISO/IEC 10373-6, while also specifying the test method of PICC in consideration of the characteristics and so forth of the PCD as specified in these implementation specifications for the purpose of evaluating PICC.

In addition, compatibility verification equipment required for testing are also specified.

14.1Test Environment

Unless specified otherwise, the test environment is to satisfy the conditions indicated in "Table 14.1-1 Test Environment".

Table 14.1-1 Test Environment

Item	Condition
Temperature	23 ± 3°C(73°F ± 5°F)
Humidity	Relative humidity of 40-60%

14.2Test Apparatus

The test apparatus and test circuits for verifying the operation of PICC are specified. The following are included in the test apparatus.

(a) Compatibility Verification Equipment
- Calibration coil
- Test PCD
- Reference PICC

(b) Measuring Instrument
- Digital sampling oscilloscope

In addition, a test PCD-S having a small antenna shape of the PCD is specified as the compatibility verification equipment based on an assumption of a form of use based on these implementation specifications.

14.2.1 Calibration Coil

(1) Basic Specifications

(a) Size of the Calibration coil card

The calibration coil card shall consist of an area which has the height and width of an ID-a type defined in ISO/IEC 7810 containing a single turn coil concentric with the card outline.
An outline drawing of the calibration coil is shown in "Fig. 14.2-1 Calibration coil".

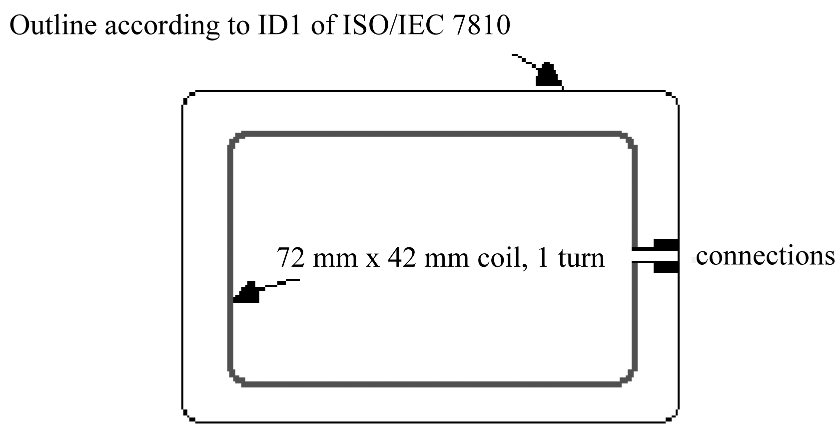


Fig. 14.2-1 Calibration coil

(b) Thickness and material of the Calibration coil card

The thickness of the calibration coil card shall be 0.76 mm ± 10%.
It shall be constructed of a suitable insulating material.

(c) Coil Characteristics

The coil on the calibration coil card shall have one turn.

The outer size of the coil shall be 72 mm x 42 mm with corner radius 5 mm. Relative dimensional tolerance shall be ±2%.

(NOTE: The area over which the field is integrated is approximately 3000 mm^2.)

The coil shall be made as a printed coil on PCB plated with 35 µm copper. Track width shall be 500 µm with a relative tolerance of ± 20%. The size of the connection pads shall be 1.5 mm x 1.5 mm.

(NOTE: At 13.56 MHz the approximate inductance is 200 nH, and approximate resistance is 0.25 Ohm.)

A high impedance oscilloscope probe (e.g. > 1MOhm, < 14pF) shall be used to measure the (open circuit) voltage induced in the coil.

The resonance frequency of the calibration coil and connecting leads 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: The signal on the terminals of the calibration coil should be measured with high impedance probe which does not load the coil significantly.)

(2) Extended Specifications

Two types of calibration coils consisting of calibration coil S and calibration coil L having different coil surface areas than the calibration coil specified in the basic specifications are specified in order to consider magnetic field distribution.

(a) Calibration Coil Dimensions

An outline drawing of the calibration coil is shown in "Fig. 14.2-2 Calibration coil".
The calibration coil S card and calibration coil L card shall consist of an area which has the height and width defined in ISO/IEC 7810 containing a single turn coil concentric with the card outline.

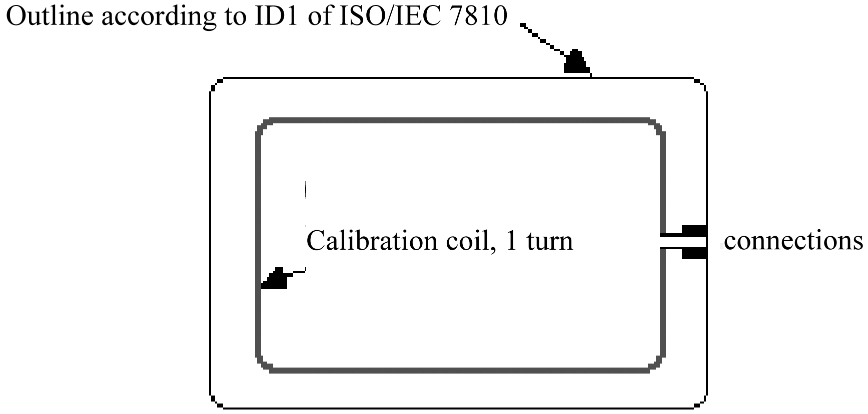


Fig. 14.2-2 Calibration coil

(b) Thickness and material of the Calibration coil card

The thickness of the calibration coil card shall be 0.76 mm ± 10%.
It shall be constructed of a suitable insulating material.

(c) Coil Characteristics

Calibration coil characteristics are shown in "Table 14.2-1 Calibration Coil Characteristics".

Table 14.2-1 Calibration Coil Characteristics

Item	Description		
	Calibration coil - S	Calibration coil - L	Calibration coil (basic specifications)
Coil dimensions	66.6 mm ± 2% x 31 mm ± 2%, corner R 8.5 mm ± 2%	83.6 mm ± 2% x 52 mm ± 2%, corner R 5 mm ± 2%	72 mm ± 2% x 42 mm ± 2%, corner R 5 mm ± 2%
Coil area	2003 mm^2	4326 mm^2	3003 mm^2
Conversion to magnetic field	1A/m (rmS) = 214.4 mV (rmS)	1A/m (rmS) = 463. 1mV (rmS)	1A/m (rmS) = 320 mV (rmS)
Pattern width	0.5 mm ± 20%	Same as left	Same as left
Pattern interval	0.5 mm ± 20%	Same as left	Same as left
Pattern material	Copper foil	Same as left	Same as left
Pattern thickness	35 μm	Same as left	Same as left
No. of turns	1 turn	Same as left	Same as left
Inductance (at 13.56 MHz)	-	-	200 nH
Resistance value (at 13.56 MHz)	-	-	0.25 Ohm

(3) References

None

14.2.2 Test PCD

(1) Basic Specifications

The test PCD assembly shall consist of a 150mm diameter PCD antenna and two parallel sense coils: sense coil a and sense coil b. The test set-up is shown in "Fig. 14.2-3 Load Modulation Measuring Circuit". The sense coils shall be connected such that the signal from one coil is in opposite phase to the other. The 50 Ohm potentiometer serves to fine adjust the balance point when the sense coils are not loaded by a PICC or any magnetically coupled circuit. The capacitive load of the probe including its parasitic capacitance shall be less than 14 pF.

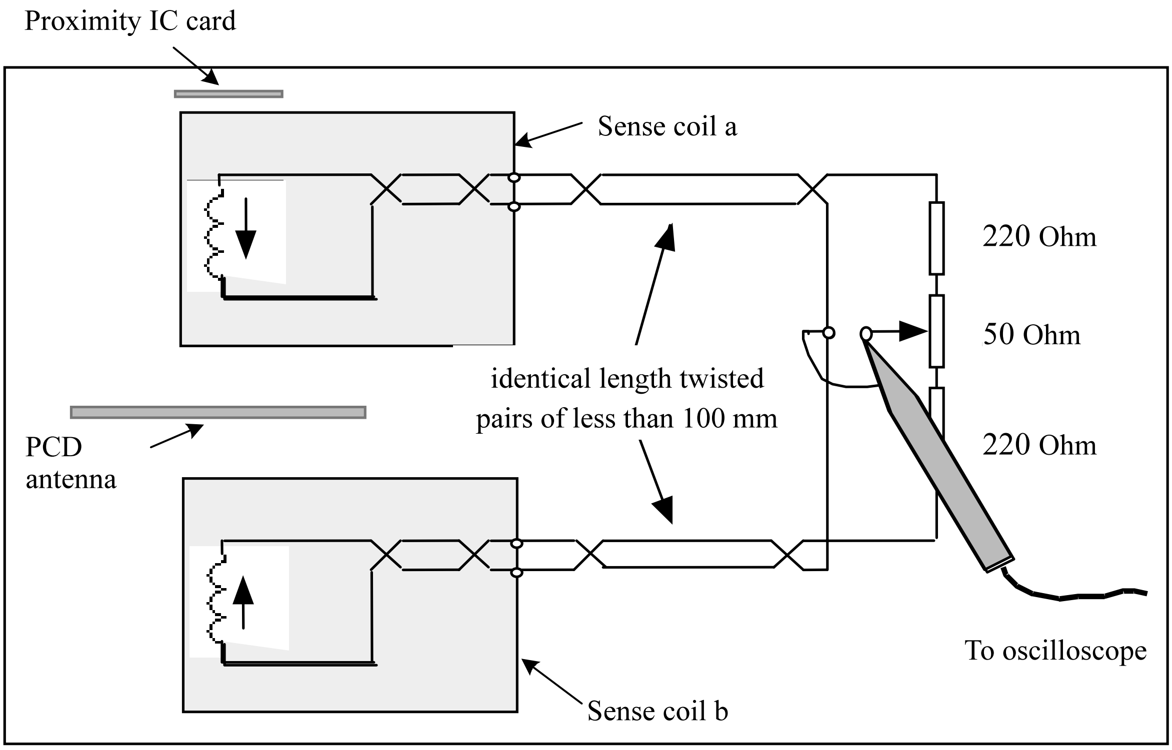


Fig. 14.2-3 Load Modulation Measuring Circuit

(a) Test PCD Antenna

The Test PCD antenna shall have a diameter of 150 mm and its construction shall conform to the drawings in "(d) Test PCD Antenna".

The tuning of the antenna may be accomplished with the procedure given in "(e) Test PCD Antenna Adjustment".

(b) Sense Coils

The size of the sense coils shall be 100 mm x 70 mm. The sense coil construction shall conform to the drawings in "(f) Sensor Coils".

(c) Assembly of Test PCD

The sense coils and Test PCD antenna shall be assembled parallel and with the sense and antenna coils coaxial and such that the distance between the active conductors is 37.5mm as in "Fig. 14.2-4 Test PCD Assembly".

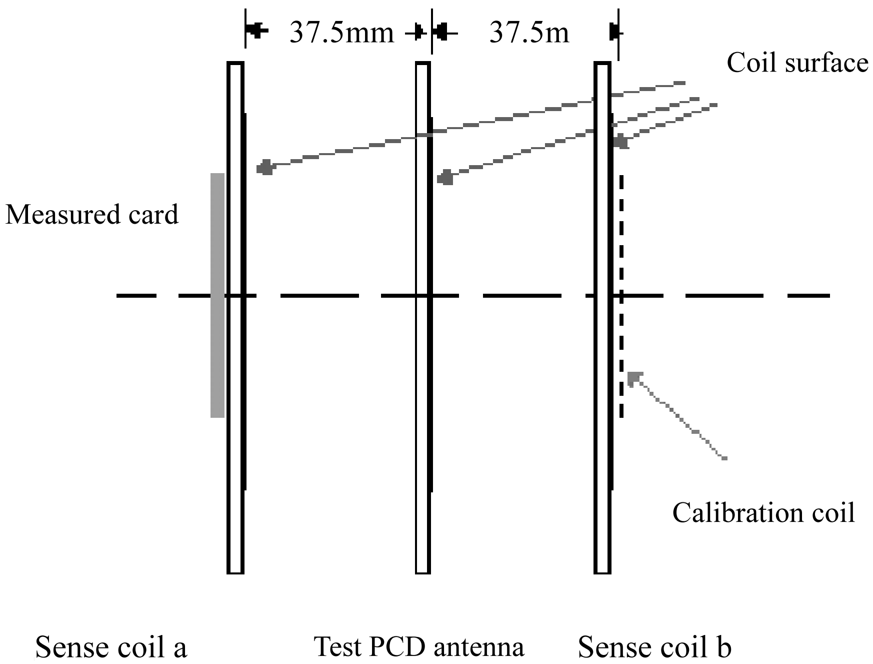
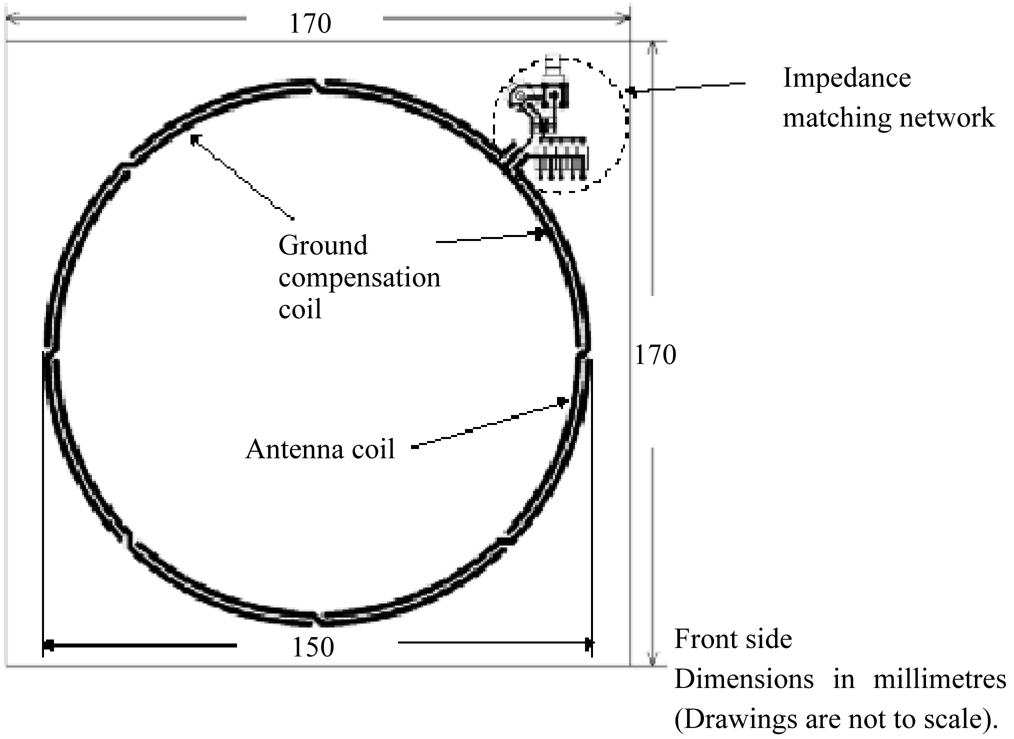


Fig. 14.2-4 Test PCD Assembly

(d) Test PCD Antenna

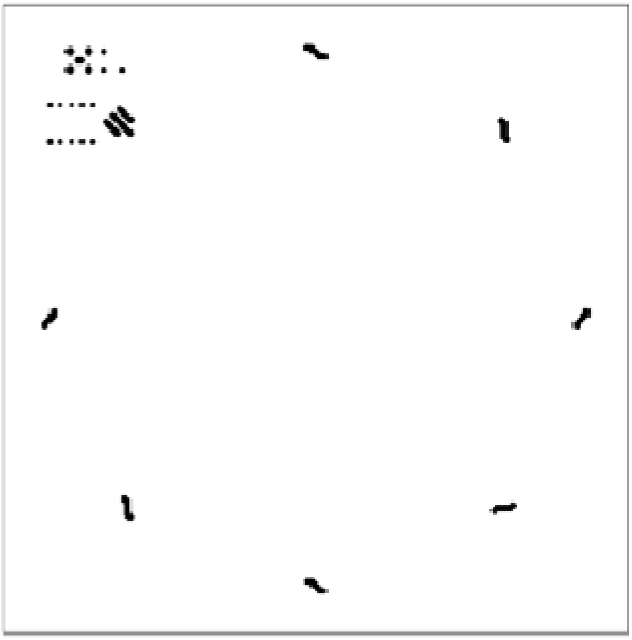
a) Layout Drawing of Antenna and Impedance Matching Network

The structure of the test PCD antenna is shown in "Fig. 14.2-5 Test PCD Antenna Layout (View from front)" and "Fig. 14.2-6 Test PCD Antenna Layout (View from back)".



(Note: The antenna coil track width is 1.8 mm (except for through-plated holes).
Starting from the impedance matching network there are crossovers every 45°.
PCB: FR4 material thickness 1.6 mm, double sided with 35 µm copper.)

Fig. 14.2-5 Test PCD Antenna Layout (View from front)



Back side

Fig. 14.2-6 Test PCD Antenna Layout (View from back)

b) Impedance matching network

The antenna impedance (Rant, Lant) is adapted to the signal generator output impedance (Z=50 Ohm) by a matching circuit (see "Fig. 14.2-7 Impedance Matching Network" and "Table 14.2-2 Component Table").

The capacitors C1, C2 and C3 have fixed values. The input impedance phase can be adjusted with the variable capacitor C4.

(Note: Care has to be taken to keep maximum voltages and maximum poser dissipation within the specified limits of the individual components.)

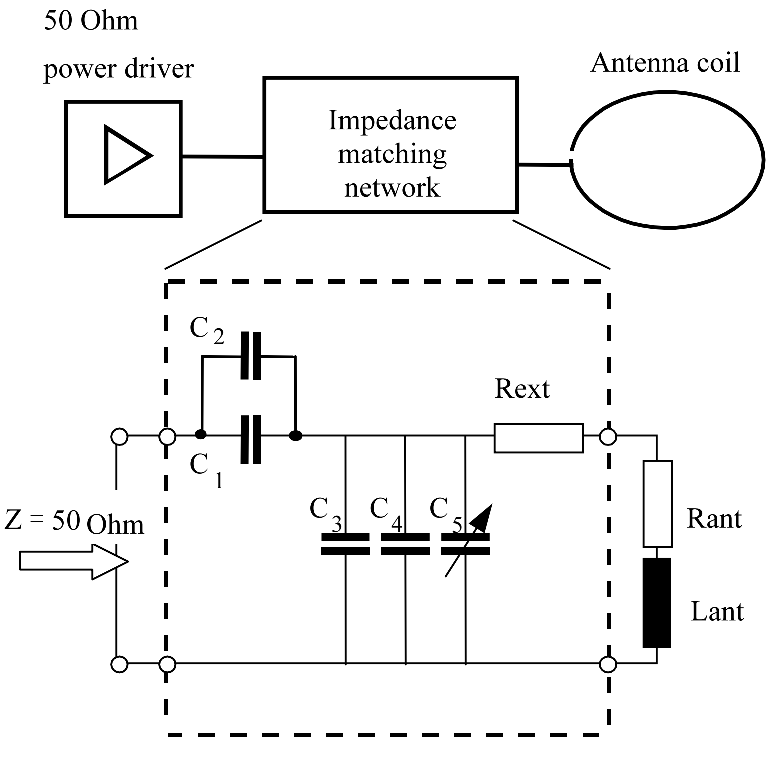


Fig. 14.2-7 Impedance Matching Network

Table 14.2-2 Component Table

	Value	Unit
C1	39	pF
C2	8.2	pF
C3	180	pF
C4	33	pF
C5	2 - 27	pF
Rext	5 x 4.7 (parallel)	Ohm

(e) Test PCD Antenna tuning

A two step simple phase tuning procedure is used to match the impedance of the antenna to that of the driving generator. After the two steps of the tuning procedure the signal generator shall be directly connected to the antenna output for the tests.

Step 1:

A high precision resistor of 50 Ohm ± 1 % (e.g. 50 Ohm BNC resistor) is inserted in the signal line between the signal generator output and an antenna connector. The two probes of the oscilloscope are connected to both sides of the serial reference resistor. The oscilloscope displays a Lissajous figure when it is set in Y to X presentation.

The signal generator is set to:

Wave form: Sinusoidal
Frequency: 13.56 MHz
Amplitude: 2V (rms) - 5V (rms)

The probe, which is in parallel to the output connector has a small parasitic capacitance C_{probe}. A calibration capacitance C_{cal} in parallel to the output connector compensates this probe capacitor if $C_{cal} = C_{probe}$. The output is terminated with a second high precision resistor of 50 Ohm ± 1 % (e.g. 50 Ohm BNC terminating resistor). The probe capacitor is compensated when the Lissajous figure is completely closed.

The adjustment method is shown in "Fig. 14.2-8 Calibration set-up - Step1".

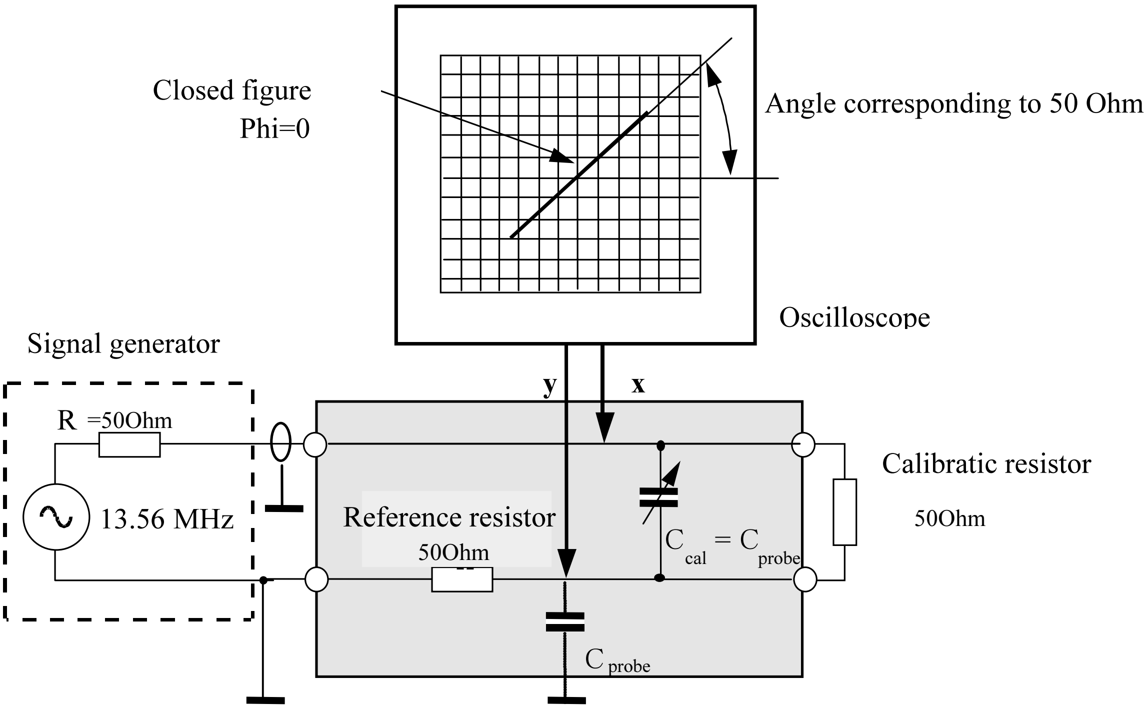


Fig. 14.2-8 Calibration set-up - Step 1

(Note: The ground cable has to be run close to the probe to avoid induced voltages caused by the magnetic field.)

Step 2:
Using the same values as set for step 1, in the second step the matching circuitry is connected to the antenna output. The capacitor C5 on the antenna board is used to tune the phase to zero. The adjustment method is shown in "Fig. 14.2-9 Calibration set-up - Step 2".

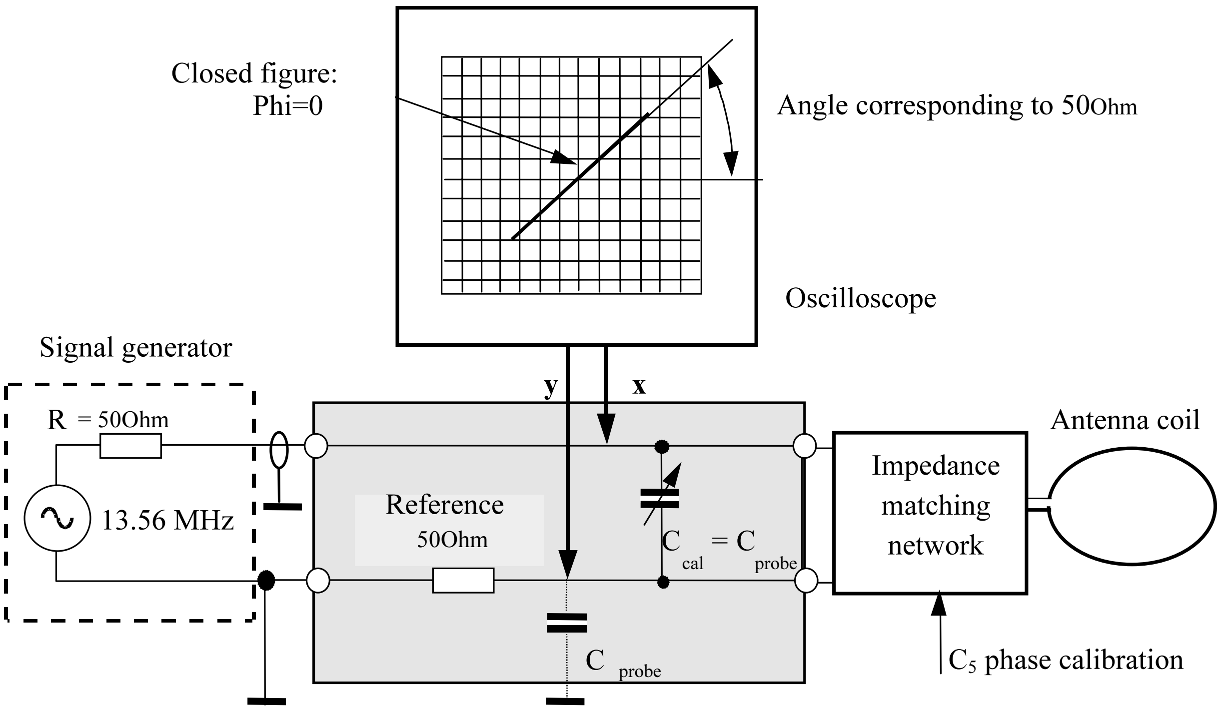
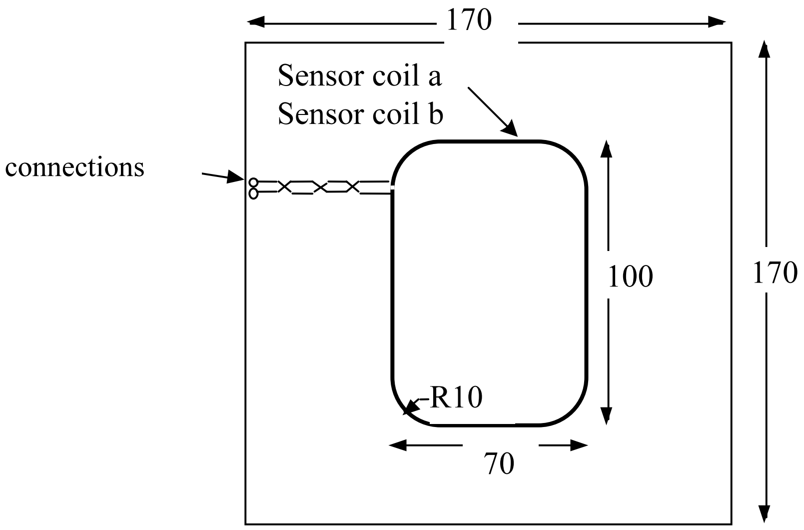


Fig. 14.2-9 Calibration set-up - Step 2

(f) Sense Coils

a) Sense coil layout

The structure of the sensor coil is shown in "Fig. 14.2-10 Sense Coil Layout".



Dimensions in millimetres
(Drawings are not to scale).

(Note: PCB: FR4 material thickness 1.6 mm, double sided with 35 µm copper.)The sense coil track width is 0.5 mm with relative tolerance ± 20 % (except for through-plated holes). Size of the coils refers to the outer dimensions.

Fig. 14.2-10 Sense Coil Layout

b) Sense Coil Assembly

The sensor coil assembly drawing is shown in "Fig. 14.2-11 Sense Coil Assembly". This assembled state is the test PCD.

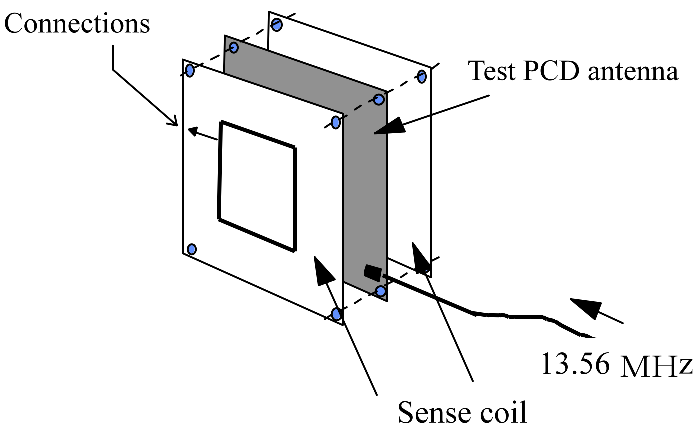


Fig. 14.2-11 Sense Coil Assembly

(2) Extended Specifications

a) Impedance Matching Network

The impedance matching network is shown in "Fig. 14.2-12 Impedance Matching Network" and "Table 14.2-3 Component Table".

This network has adjustment capacitor C6 added to the basic specifications, and is used to more accurately perform impedance adjustment.

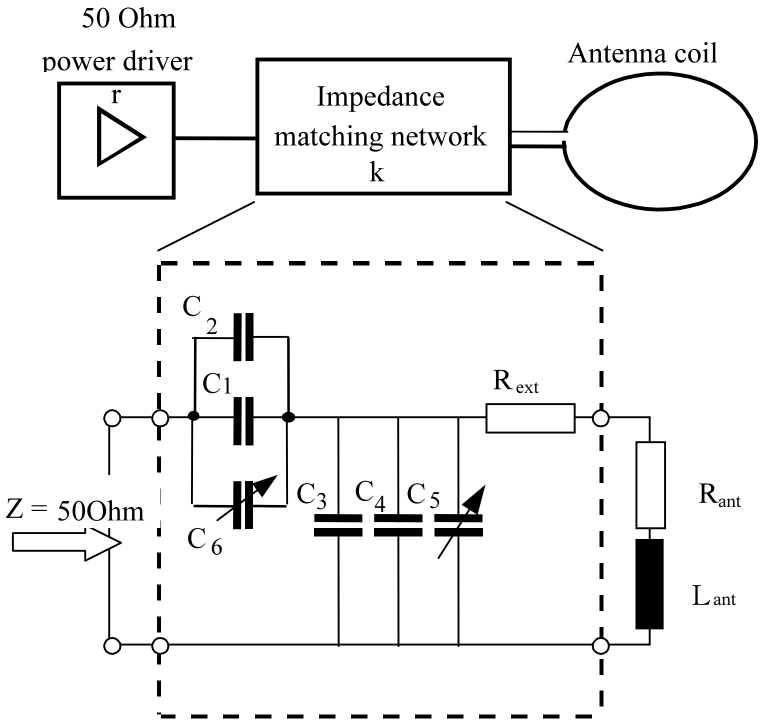


Fig. 14.2-12 Impedance Matching Network

Table 14.2-3 Component Table

	Value	Unit
C1	39	pF
C2	8.2	pF
C3	180	pF
C4	33	pF
C5	2 - 27	pF
C6	2 - 27	pF
Rext	5 x 4.7 (parallel)	Ohm

b) Test PCD Antenna tuning

1) Adjustment Using an Oscilloscope

Phase adjustment is performed with capacitors C5 and C6 in step 2 for the adjustment method specified in the basic specifications.

2) Adjustment Using Network Analyzer

The test PCD is connected to a network analyzer followed by measurement of impedance by measuring S11. Adjustment is made so that the impedance of the test PCD antenna reaches an impedance of 50 Ohm ± 1% (induction component or capacitance component shall be 0 Ohm) at a frequency of 13.56 MHz.

(3) References

None

14.2.3 Test PCD-S

(1) Basic Specifications

None

(2) Extended Specifications

(a) Test PCD-S Antenna

Antenna specifications of the test PCD-S are shown in "Table 14.2-4 Test PCD-S Antenna Specifications".

Table 14.2-4 Test PCD-S Antenna Specifications

Name	Description	
Antenna coil	Coil outer diameter	ø38 ± 0.2mm
	Pattern width	0.5mm
	Pattern interval	0.5mm
	Pattern thickness	35μm
	No. of turns	3 turns
	Structure	Formed with copper foil on a printed board
Antenna board	Size	120mm × 100mm
	Thickness	t1.6mm
	Material	FR4
Impedance matching network	Impedance is matched between the antenna coil and output circuit at 50 Ohm.	

(b) Structure

The test PCD-S circuit is shown in "Fig. 14.2-13 Test PCD-S Circuit ", while the structure of the test PCD-S is shown in "Fig.14.2-14 Test PCD-S Structure".

The calibration coil and test PCD-S antenna shall be arranged in parallel so that the central axes of the calibration coil and test PCD-S antenna coil are aligned. At this time, the test PCD-S is assembled so that the interval between the effective conductor surfaces is 15 mm as shown in "Fig. 14.2-14 Test PCD-S Structure".

In addition, a 5 mm spacer is arranged between the test PCD-S and measured card, and the spacer surface is defined as the reference surface (distance: 0 mm) of the test PCD-S, while the antenna center of the test PCD-S is defined as the central position.

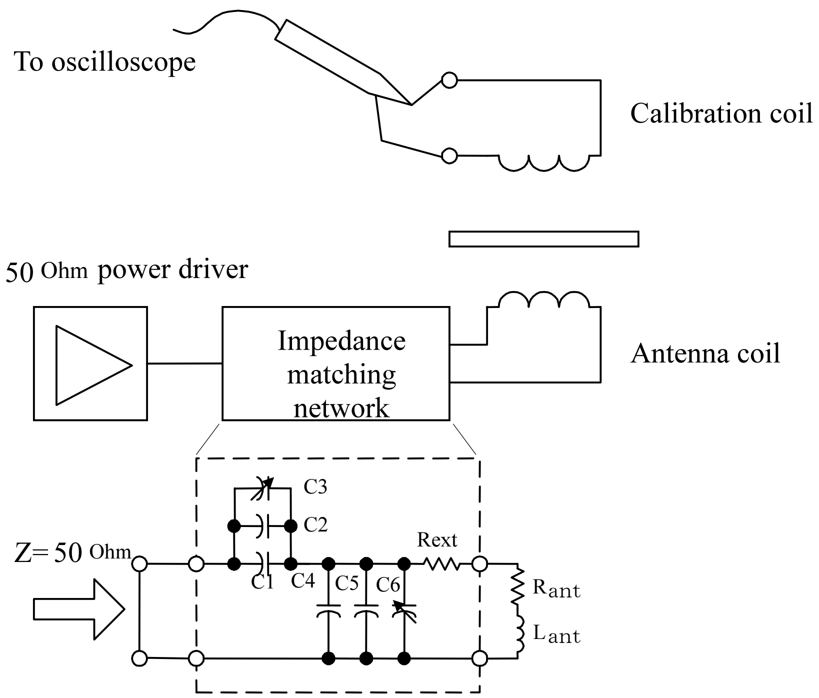


Fig. 14.2-13　Test PCD-S Circuit

'

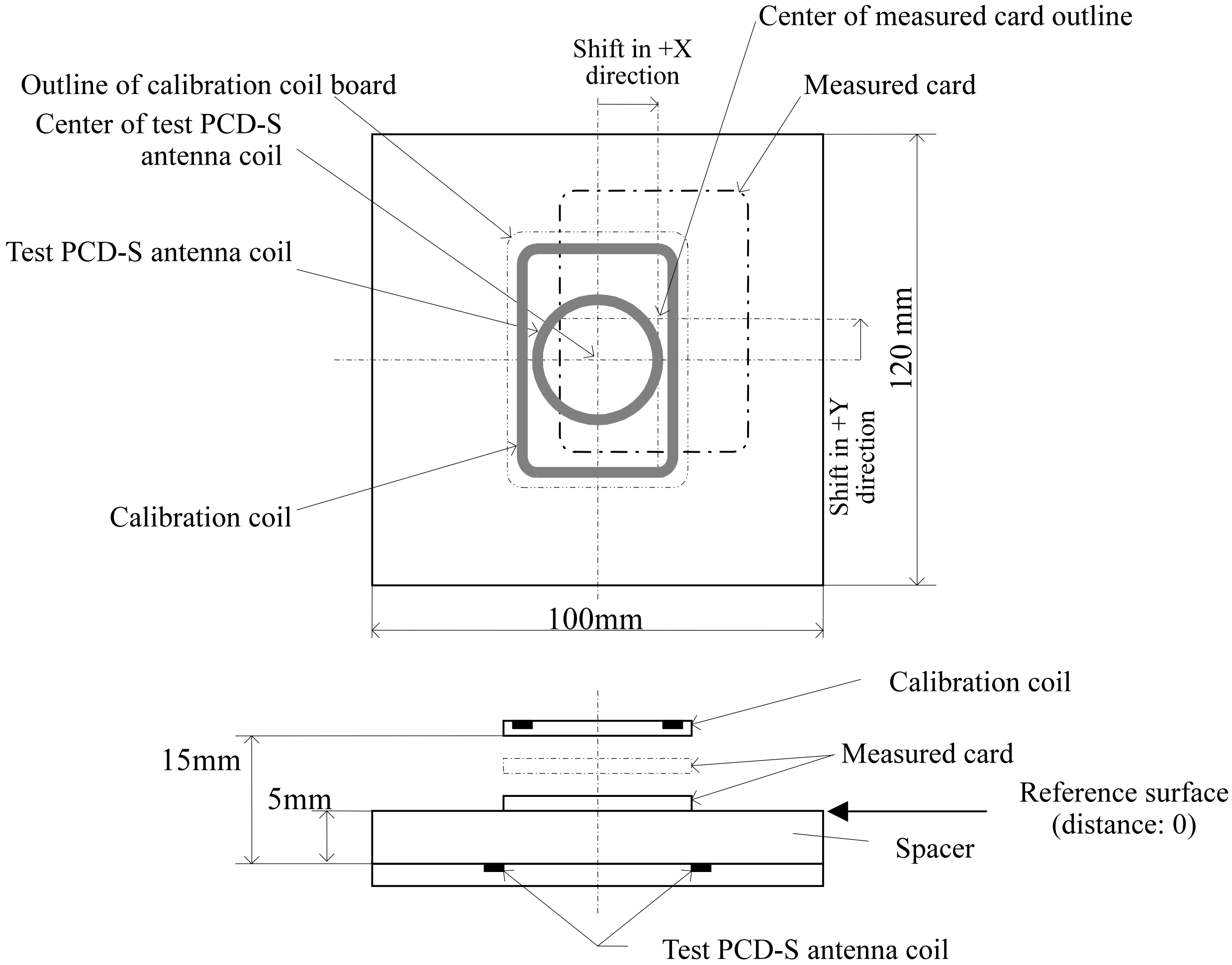


Fig. 14.2-14 Test PCD-S Structure

c) Calibration

a) Antenna Output

The antenna output is to be magnetic field strength (7) A/m ±5% at the calibration coil. The position of the calibration coil is to be at distance 0 mm without any shift.

b) Modulation Waveform

The modulation waveform is calibrated so that the modulation waveform becomes the specified waveform by measuring the modulation waveform at the calibration coil. The position of the calibration coil is to be at distance 0 mm without any shift.

(3) References

None

14.2.4 Digital Sampling Oscilloscope

(1) Basic Specifications

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. 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 programs.

(2) Extended Specifications

None

(3) References

None

14.3Test Methods

14.3.1 Testing Using Test PCD

14.3.1.1 Functional Tests

(1) Basic Specifications

This test measures the amplitude of the load modulation signal of the PICC within the operating magnetic field region defined by the PCD.

(a) Test Method

Step 1:

The load modulation test circuit shown in "Fig. 14.2-3 Load Modulation Measuring Circuit" and the test PCD shown in "Fig. 14.2-4 Test PCD Assembly" are used.

Adjust the current in the PCD antenna to the required field strength as measured by the calibration coil. Connect the output of the load modulation test circuit of "Fig 14.2-3 Load Modulation Measuring Circuit" to the digitizing sampling oscilloscope. The 50 Ohm potentiometer shall be trimmed to minimize the residual carrier. This signal shall be at least 40dB lower than the signal obtained by shorting one sense coil.

(Note: The waveform of the load modulated subcarrier (fc) is measured with a digitizing sampling oscilloscope capable of sampling at a rate of 100 million samples per second with a resolution of 8 bits at optimum scale.)

Step 2:

The PICC under test shall be placed in the DUT position, concentric with sense coil a. The RF drive into the test PCD antenna shall be re-adjusted to the required field strength.

Display a segment of at least two cycles of the waveform of the subcarrier load modulation on the digital sampling oscilloscope and store the sampled data in a file for analysis by a computer software programme.

Fourier transform exactly two subcarrier cycles of the sampled modulation waveform using suitable computer software. Use a discrete Fourier transformation with a scaling such that a pure sinusoidal signal results in its peak magnitude. To minimize transient effects, avoid a subcarrier cycle immediately following a non-modulation period.

The resulting peak amplitudes of the upper and lower sidebands at $fc + fs$ and $fc - fs$ shall be above the value defined in "10.1.2 Load Modulation".

A REQA or a REQB command sequence as define in "12. Anticollision" shall be sent by the Test PCD to obtain a signal or load modulation response from the PICC.

(b) Measurements

The amplitude values of the upper and lower band frequencies of ($f_C + f_S$) and ($f_C - f_S$) of the response signal generated by the PICC are measured.

(2) Extended Specifications

These test items only apply to cards premised on two card operation.

(a) Test Method

Testing is performed under the condition of superimposing two card to be tested.

a) Case of Superimposing Two PICC

Place two PICC in the test PCD while superimposing them on each other after which an REQ signal is sent by the test PCD. Check the modulation signal from the PICC with an oscilloscope connected to the calibration coil. In the case the response from the two PICC interferes, perform anticollision processing and measure in the absence of collision.

b) Case of Superimposing a PICC and Reference PICC

Place the PICC in the test PCD while superimposed with the power transmission testing reference PICC (3 types) as specified in "15.2.1 Reference PICC" after which an REQ signal is sent by the test PCD. Check the modulation signal from the PICC with an oscilloscope connected to the calibration coil.

(b) Measurements

Measure the amplitude values of the upper and lower band frequencies ($f_C + f_S$) and ($f_C - f_S$) of the response signal generated by the PICC.

(3) References

None

14.3.1.2 Minimum Operating Magnetic Field Test

This test measures the minimum operating magnetic field of the PICC.

(1) Basic Specifications

(a) Test Method

The minimum operating magnetic field at which a response is generated from the PICC is measured according to the test method specified in the extended specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The minimum operating magnetic field must satisfy "8.2 Operating Magnetic Field".

(2) Extended Specifications

These test items apply only to cards premised on two card operation.

(a) Test Method

The minimum operating magnetic field at which a response is generated from the PICC is measured according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The minimum operating magnetic field must satisfy "8.2 Operating Magnetic Field".

(3) References

None

14.3.1.3 Maximum Operating Magnetic Field Test

This test measures the maximum operating magnetic field of the PICC.

(1) Basic Specifications

(a) Test Method

The maximum operating magnetic field at which a response is generated from the PICC is measured according to the test method specified in the extended specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The maximum operating magnetic field must satisfy "8.2 Operating Magnetic Field".

(2) Extended Specifications

These test items apply only to cards premised on two card operation.

(a) Test Method

The maximum operating magnetic field at which a response is generated from the PICC is measured according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The maximum operating magnetic field must satisfy "8.2 Operating Magnetic Field".

(3) References

None

14.3.1.4 Maximum Applied Magnetic Field Test

This test measures the maximum applied magnetic field of the PICC.

(1) Basic Specifications

None

(2) Extended Specifications

(a) Test Method

a) Case of a Single Card

Attach a single PICC at the location of the measured card of the test PCD and apply the maximum applied magnetic field as specified in "8.2 Operating Magnetic Field".

After applying the magnetic field, check the function of the PICC according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

b) Case of Superimposing Two Cards

These test items apply only to cards premised on two card operation.

1) Case of Superimposing Two PICC

Attach the two PICC at the location of the measured card of the test PCD while superimposed on each other, and apply the maximum applied magnetic field specified in "8.2 Operating Magnetic Field".

After applying the magnetic field, check the function of the PICC according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

2) Case of Superimposing a PICC and Reference PICC

Attach the PICC at the location of the measured card of the test PCD while superimposed with a single power transmission testing reference PICC as specified in "15.2.1 Reference PICC", and apply the maximum applied magnetic field specified in "8.2 Operating Magnetic Field".

After applying the magnetic field, check the function of the PICC according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The PICC must function normally after applying the magnetic field.

(3) References

None

14.3.1.5 Signal Receive Test

This tests the signal receive function of the PICC.

(1) Basic Specifications

None

(2) Extended Specifications

(a) Test Method

The modulation signal from the test PCD is adjusted to the modulation waveform specified in "9.1.2 Modulation" or "9.2.2 Modulation".

Measure the response from the PICC according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

(b) Specifications

The response from the PICC must be generated in the form of the modulation waveform specified in "9.1.2 Modulation" or "9.2.2 Modulation" within the range specified in "8.2 Operating Magnetic Field".

(3) References

None

14.3.1.6 Load Modulation Test

This test measures the magnitude of the load modulation of the PICC.

(1) Basic Specifications

(a) Test Method
Measure the response from the PICC according to the test method specified in the basic specifications of "14.3.1.1 Functional Tests".

(b) Specifications
The PICC must satisfy the specifications of "10.1.2 Load Modulation" or "10.2.2 Load Modulation".

(2) Extended Specifications

These test items apply only to cards premised on two card operation.

(a) Test Method
Measure the response from the PICC according to the test method specified in the extended specifications of "14.3.1.1 Functional Tests".

(b) Specifications
The PICC must satisfy the specifications of "10.1.2 Load Modulation" or "10.2.2 Load Modulation".

(3) References

None

14.3.1.7 Reference PICC Superimposition Test

(1) Basic Specifications

None

(2) Extended Specifications

These test items apply only to cards premised on two card operation.

The effect of the PICC on the reference PICC specified in "15.2.1 Reference PICC" is measured.

(a) Power Transfer Testing

a) Testing Using Test PCD

1) Test Method

Connect jumper J1 to resistor R3 of the power transmission testing reference PICC specified in the extended specifications of "15.2.1 Reference PICC", attach two superimposed power transmission testing reference PICC at the position of the measured card of the test PCD, and adjust the output of the test PCD so that the voltage at both ends of R3 of the power transmission testing reference PICC becomes 6.8 V.

Next, attach a PICC superimposed with a single power transmission testing reference PICC at the location of the measured card of the test PCD, and measure the received power of the power transmission testing reference PICC .

b) Specifications

The received voltage of the reference PICC must be 6.8 V or more.

(3) References

None

14.3.2 Testing Using Test PCD-S

14.3.2.1 Functional Tests

(1) Basic Specifications

None

(2) Extended Specifications

None

(3) References

Confirm that the PICC operates with the test PCD-S.

(a) Test Method

Place the measured card in the test PCD-S and send REQA or REQB as specified in "12. Anticollision" from the test PCD-S. Check the modulation signal from the PICC with an oscilloscope connected to the calibration coil.

Perform testing for both the case of using a single card and superimposing two cards. When superimposing two cards, measure for two superimposed measured cards as well as for the case of superimposing the measured card with the power transmission testing reference PICC specified in "15.2.1 Reference PICC".

(b) Measurements

Check the modulation signal from the PICC over the operating range of the test PCD-S.

- Test PCD-S operating range:
  Distance: 0-5 mm
  Shift: ø 5 mm

(c) Specifications

There must be a modulation signal from the PICC over the operating range of the test PCD-S.

15. PCD Test Methods

In addition to specifying test methods of the PCD based on ISO/IEC 10373-6, test methods of the PCD are specified in consideration of PICC characteristics specified in these implementation specifications for the purpose of evaluating the PCD.

In addition, compatibility verification equipment required for testing are also specified.

15.1Test Environment

Unless specified otherwise, the test environment is to satisfy the conditions indicated in "Table 15.1-1 Test Environment".

Table 15.1-1 Test Environment

Item	Condition
Temperature	23 ± 3°C(73°F ± 5°F)
Humidity	Relative humidity of 40-60%

15.2 Test Apparatus

The test apparatus and test circuits for verifying the operation of PCD are specified based on ISO/IEC 10373-6. The test apparatus include that indicated below.

(a) Compatibility Verification Equipment

- Reference PICC

15.2.1 Reference PICC

The reference PICC used to evaluate the performance of PCD is specified.

(1) Basic Specifications

Reference PICCs are defined:
- to test H_{min} and H_{max} produced by a PCD (under conditions of loading by a PICC)
- to test the ability of a PCD to power a PICC
- to detect the minimum load modulation signal from the PICC.

(a) Reference PICC for Power Transmission Testing

This is used for measurement of the minimum and maximum generated magnetic fields as well as power transmission testing.

The schematic for the power transmission test is shown in "15.2.1 (f) a) Reference PICC for Power Transmission Testing". Resistors R1 and R2 may be selected by means of jumper J1. The resonant frequency can be adjusted with capacitor CV1.

(b) Reference PICC for Load Modulation Testing

The schematic for load modulation testing is shown in "15.2.1 (f) b) Reference PICC for Load Modulation Testing". The load modulation can be chosen to be resistive or capacitive.

This reference PICC is calibrated by using the Test PCD assembly as follows:

- Place reference PICC in the position of the DUT.
- Measure the load modulation signal amplitude as described in "14.3.1.1 Functional Tests". This amplitude should correspond to the minimum amplitude at values of field strength required by "10.1.2 Load Modulation".

(c) Dimensions of the Reference PICCs

The Reference PICCs shall consist of an area containing the coils which has the height and width defined in ISO/IEC 7810 for ID-1 type. An area external to this, containing the circuitry which emulates the required PICC functions, shall be appended in such a way as to allow insertion into the test set-ups described below and so as to cause no interference to the tests. The dimensions shall be as in "Fig. 15.2-1 Reference PICC Dimensions".

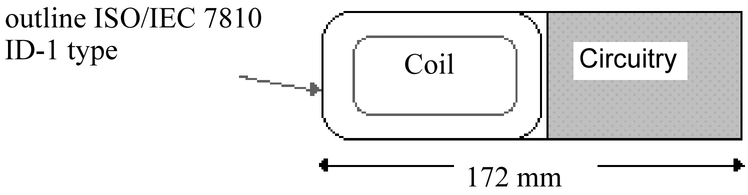


Fig. 15.2-1 Reference PICC Dimensions

(d) Thickness of the Reference PICCs board

The thickness of the Reference PICCs active area shall be 0.76 mm ± 10 %.

(e) Coil Characteristics

The coil in the active area of the Reference PICCs shall have 4 turns and shall be concentric with the area outline.

The outer size of the coils shall be 72 mm x 42 mm with a relative tolerance of ± 2 %.

The coil shall be printed on PCB plated with 35 µm.

Track width and spacing shall be 500 µm with a relative tolerance of ± 20 %.

(f) Circuit Drawing

a) Reference PICC for Power Transmission Testing

The circuit drawing of the power transmission testing reference PICC is shown in "Fig. 15.2-2 Schematic of Power Transmission Testing Reference PICC ", while the components list is shown in "Table 15.2-1 Components List".

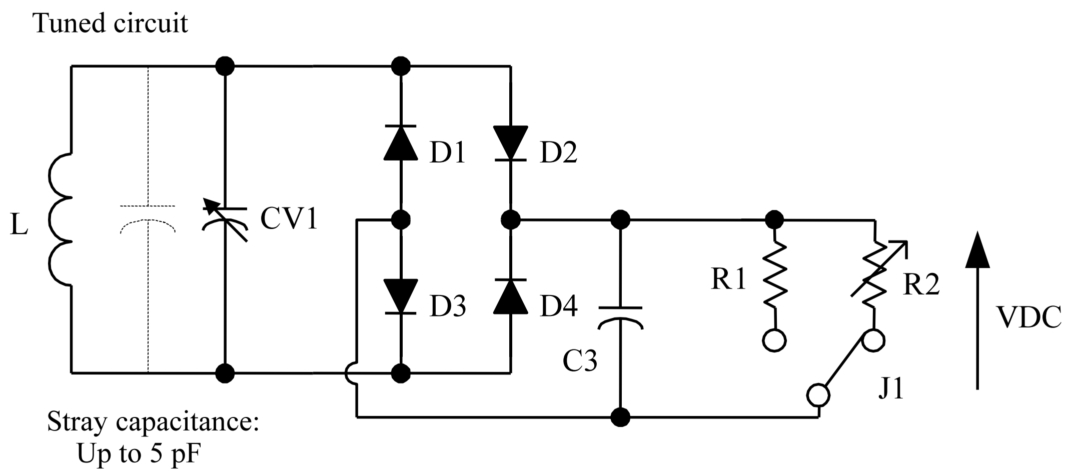


Fig. 15.2-2 Schematic of Power Transmission Testing Reference PICC

Table 15.2-1 Components List

Component	Specifications
L (Coil)	See (e) Coil Characteristics
CV1	6-60pF
C3	10nf
D1, D2, D3, D4	See Table 15.2-2 (BAR43 or equivalent)
R1	1.8 kOhm (5 mW)
R2	0-5kOhm

Table 15.2-2 Basic Characteristics of Diodes D1, D2, D3 and D4

Item	Test conditions (Tj = 25°C)	Typical	Max. value	Units
Vr	Ir=2mA		0.33	V
C	VR=1V F=1MHz	7		pF
t_{rr}	I_F=10mA, I_R=1mA, I_{rr}=1mA		5	ns

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

b) Reference PICC for Load Modulation Testing

The schematic for the reference PICC for load modulation testing is shown in "Fig. 15.2-3 Schematic of Reference PICC for Load Modulation Testing", the components for adjusting characteristics are shown in "Table 15-2-3 Emulation Circuit Adjustable Component List", and fixed components are shown in "Table 15-2-4 Components List".

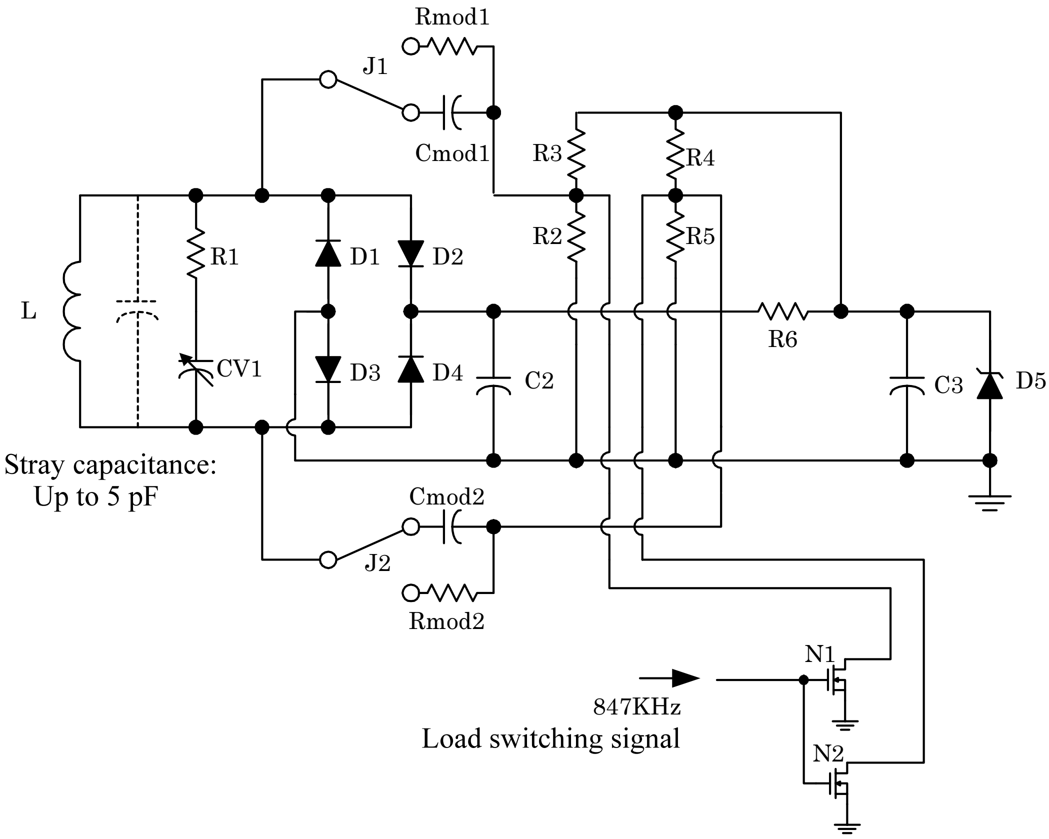


Fig. 15.2-3 Schematic of Reference PICC for Load Modulation Testing

Table 15-2-3 Emulation Circuit Adjustable Component List

Component	Function	Specifications
R1	adjust Q	0~10 Ohm
CV1	adjust resonance	Accordig to a request
Cmod1, Cmod2	Capacitive modulation	3.3~10 pF
Rmod1, Rmod2	Resistive modulation	400~12 kOhm
R6	Shunt Current	10 Ohm~5 kOhm
D5	Shunt Voltage	2.7~15 V

Table 15-2-4 Components List

Component	Specifications
R2	1 MOhm
R3	1 MOhm
R4	1 MOhm
R5	1 MOhm
D1, D2, D3, D4	See Table 15.2-2 (BAR43 or equivalent)
L (Coil)	See (e) Coil Characteristics
CV1	6-60 pF
C2	100 pF
C3	10 nf
N1, N2	N-MOS transistor (ground capacitance of 10 pF or less)

(2) Extended Specifications

A reference PICC having a different coil shape and circuit constant from the reference PICC specified in the basic specifications is specified in consideration of the antenna shape and presumed load conditions of PICC, and this reference PICC is used for PCD performance testing.

(a) Dimensions of the Reference PICCs

The Reference PICCs shall consist of an area containing the coils which has the height and width defined in ISO/IEC 7810 for ID-1 type. An area external to this, containing the circuitry which emulates the required PICC functions, shall be appended in such a way as to allow insertion into the test set-ups described below and so as to cause no interference to the tests. The dimenstions shall be as in "Fig. 15.2-4 Reference PICC Dimensions".

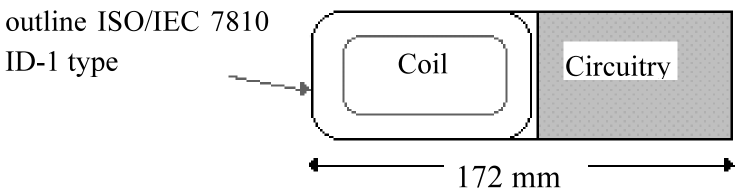


Fig. 15.2-4 Reference PICC Dimensions

(b) Thickness of Reference PICC Board

The thickness of the reference PICC active area shall be 0.76 mm ± 10%.

(c) Coil Characteristics

The characteristics of the reference PICC coil are shown in "Table 15-2-5 Reference PICC Coil Characteristics".

Table 15-2-5 Reference PICC Coil Characteristics

Item	Description		
	Reference PICC - S	Reference PICC - L	Reference PICC (basic specifications)
Coil dimensions	66.6 mm ± 2% x 31 mm ± 2%, corner R 8.5 mm ± 2% (coil inner diameter dimensions)	83.6 mm ± 2% x 52 mm ± 2%, corner R 5 mm ± 2% (coil outer diameter dimensions)	72 mm ± 2% x 42 mm ± 2%, corner R 5 mm ± 2% (coil outer diameter dimensions)
Pattern width	0.5 mm ± 20%	Same as left	Same as left
Pattern interval	0.5 mm ± 20%	Same as left	Same as left
Pattern material	Copper foil	Same as left	Same as left
Pattern thickness	35 µm	Same as left	Same as left
No. of turns	4 turns	Same as left	Same as left
Test circuit for evaluation of power transmission	Same as extended specifications	Same as left	-
Test circuit for evaluation of load modulation	Same as extended specifications	Same as left	-

(d) Circuit Drawing

a) Reference PICC for Power Transmission Testing

The circuit drawing of the power transmission testing reference PICC is shown in "Fig. 15.2-5 Schematic of Power Transmission Testing Reference PICC", while the components list is shown in "Table 15.2-6 Components List".

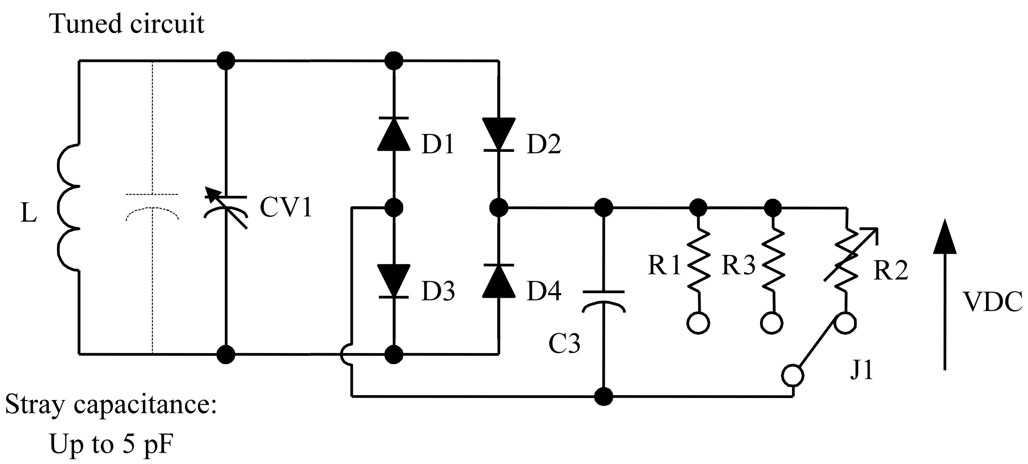


Fig. 15.2-5 Schematic of Power Transmission Testing Reference PICC

Table 15.2-6 Components List

Component	Specifications
L (Coil)	See (e) Coil Characteristics
CV1	6-60 pF
C3	10 nf
D1, D2, D3, D4	See Table 15.2-2 (BAR43 or equivalent)
R1	1.8 kOhm (5 mW)
R2	0-5 kOhm
R3	910 Ohm

b) Reference PICC for load modulation test

The schematic for the reference PICC for load modulation testing is shown in "Fig. 15.2-6 Schematic of Reference PICC for load modulation test", the components for adjusting characteristics are shown in "Table 15-2-7 Pseudo-Circuit Regulatory Part List", and fixed components are shown in "Table 15-2-8 Components List".

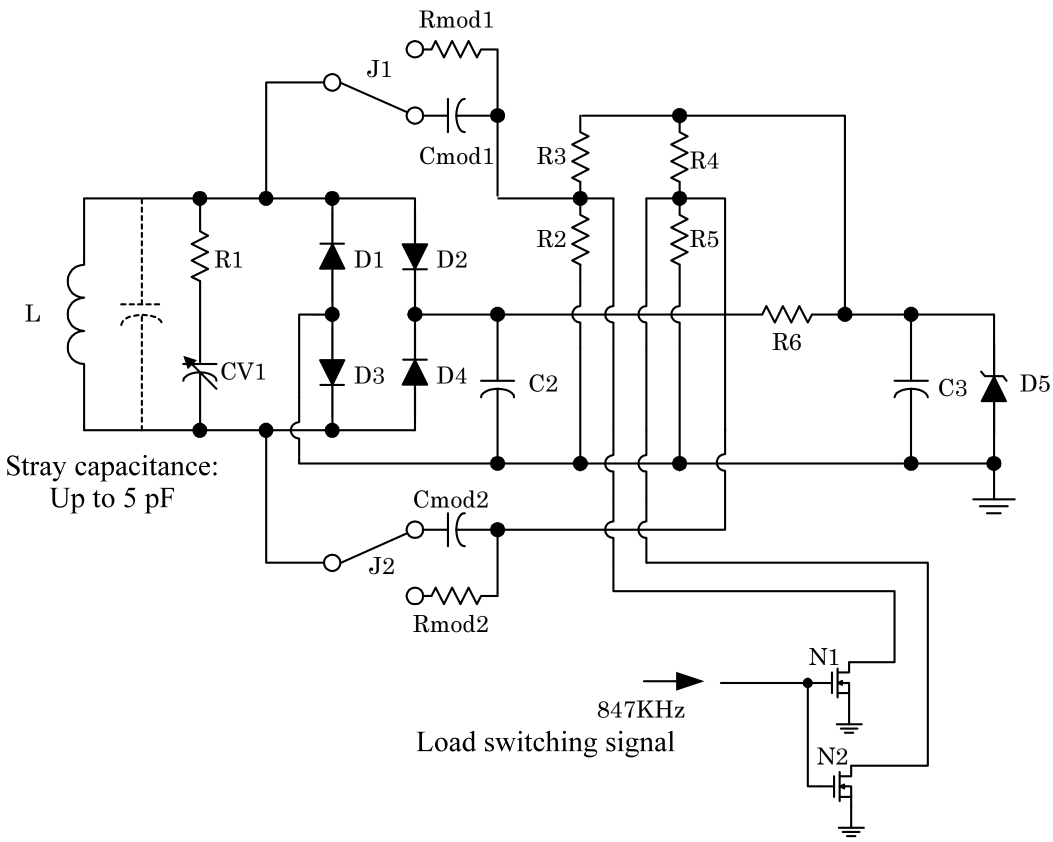


Fig. 15.2-6 Schematic of Reference PICC for load modulation test

Table 15-2-7 Pseudo-Circuit Regulatory Part List

Component	Function	Specifications
R1	adjust Q	0 Ohm
CV1	adjust Resonance	Resonance frequency: 19 MHz
Cmod1, Cmod1	Capacitive modulation	None
Rmod1, Rmod2	Resistive modulation	A resistance value shall be selected that serves as the load modulation amplitude specified in "10.1.2 Load Modulation" or "10.2.2 Load Modulation".
R6	Shunt Current	100 Ohm
D5	Shunt Voltage	5.1 V

Table 15-2-8 Components List

Component	Specifications
R2	1 MOhm
R3	1 MOhm
R4	1 MOhm
R5	1 MOhm
D1, D2, D3. D4	See Table 15.2-2 (BAR43 or equivalent)
L (Coil)	See (e) Coil Characteristics
CV1	6-60 pF
C2	100 pF
C3	10 nF
N1, N2	N-MOS transistor (ground capacitance of 10 pF or less)

c) Reference PICC for Modulation Waveform Testing

The schematic of the reference PICC for modulation waveform testing is shown in "Fig. 15.2-7 Schematic of Reference PICC for Modulation Waveform Testing", while the components list is shown in "Table 15-2-9 Components List".

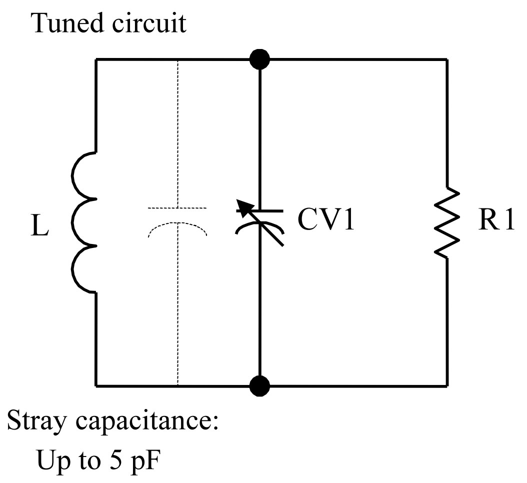


Fig. 15.2-7 Schematic of Reference PICC for Modulation Waveform Testing

Table 15-2-9 Components List

Part	Specifications
L (Coil)	See (e) Coil Characteristics
CV1	6-60 pF
R1	910 Ohm

(3) References

None

15.3Test Methods

15.3.1 Magnetic Field Strength

This test measures the magnetic field strength generated by the PCD.

(1) Basic Specifications

The strength of the magnetic field generated by the PCD within the operating range of the PCD is measured. In this test, a magnetic field is set with the reference PICC under the conditions of (1) through (3) of the following section, and the magnetic field generated by the PCD is confirmed to not exceed the value specified in "8.2.2 PCD Generated Magnetic Field".

(Note: The test is performed with the reference PICC set as the load in the PCD.)

(a) Test Method

a) Maximum Generated Magnetic Field

1) Calibrate the magnetic field generated by the test PCD to the value of the maximum generated magnetic field on the calibration coil.
2) Adjust the resonance frequency of the reference PICC to 19 MHz.
(Note: The resonance frequency of the reference PICC is measured with an impedance analyzer or a LCR-meter connected to a calibration coil. The reference PICC coil shall be placed concentric with the calibration coil and positioned as closely as possible. The resonace frequency shall be a frequency at which the reactance component of impedance reaches a maximum.)
3) The reference PICC shall be placed in the DUT position of the test PCD. Set the jumper to connect R2, measure the voltage at both ends of R2 with a high impedance voltmeter, and adjust the voltage to 3 Vdc. Observe the change in the state of the operating magnetic field by monitoring the voltage generated on the calibration coil.
4) Place the reference PICC within the operating range of the measured PCD. The voltage at both ends of R2 shall not exceed 3 Vdc when measured with a high impedance voltmeter.

b) Minimum Generated Magnetic Field

1) Calibrate the magnetic field generated by the test PCD to the value of the minimum generated magnetic field on the calibration coil.
2) Adjust the resonance frequency of the reference PICC to 13.56 MHz.
3) The reference PICC shall be placed in the DUT position of the test PCD. Set the jumper to connect R2, measure the voltage at both ends of R2 with a high impedance voltmeter, and adjust the voltage to 3 Vdc. Observe the change in the state of the operating magnetic field by monitoring the voltage generated on the calibration coil.
4) Place the reference PICC within the operating range of the measured PCD. The voltage at both ends of R2 shall exceed 3 Vdc when measured with a high impedance voltmeter.

(b) Measurements

The voltage Vdc in the minimum generated magnetic field and maximum generated magnetic field is measured.

(c) Specifications

a) Maximum generated magnetic field

Receive voltage of 3 V or less within the operating range of the PCD.

b) Minimum generated magnetic field

Receive voltage of 3 V or more within the operating range of the PCD.

(2) Extended Specifications

(a) Measurement Using Reference PICC

a) Test Method

Measure the minimum generated magnetic field and maximum generated magnetic field using the reference PICC-S and reference PICC-L specified in the extended specifications of "15.2.1. Reference PICC".

The test method is the same as that of the basic specifications.

b) Measurements

Measurements are the same as those of the basic specifications.

c) Specifications

1) Maximum generated magnetic field

Receive voltage of 3 V or less within the operating range of the PCD.

2) Minimum generated magnetic field

Receive voltage of 3 V or more within the operating range of the PCD.

(b) Measurement Using Calibration Coil

a) Test Method

Measure the magnetic field within the operating range of the PCD with the calibration coil (basic specifications) specified in "14.2.1 Calibration Coil".

b) Measurements

The maximum magnetic field and minimum magnetic field within the operating range of the PCD are measured.

c) Specifications

1) Maximum generated magnetic field

Must be equal to or less than the maximum operating magnetic field specified in "8.2.2 PCD Generated Magnetic Field".

2) Minimum generated magnetic field

Must be equal to or greater than the minimum operating magnetic field specified in "8.2.2 PCD Generated Magnetic Field".

(3) References

None

15.3.2 Power Transmission Test

This test is conducted to confirm that the PCD is able to supply the required power to the PICC no matter where the PICC is placed in the operating range of the PCD.

(1) Basic Specifications

(a) Test Method

Connect a jumper to resistor R1 of the reference PICC and adjust the resonance frequency of the reference PICC to 19 MHz. Measure the voltage generated at both ends of R1 with a high impedance voltmeter.

(b) Measurements

The voltage generated at both ends of R1 is measured within the operating range of the PCD.

(c) Specifications

Receive voltage of reference PICC: 3 V or more

(2) Extended Specifications

None

(3) References

(a) Test Method

Measure using the reference PICC for power transmission testing specified in the extended specifications of "15.2.1 Reference PICC".

The test method is the same as that of the basic specifications.

a) Measurement with a single reference PICC

Connect a jumper to resistor R3 of the reference PICC and adjust the resonance frequency to 19 MHz. Measure the voltage generated at both ends of R3 with a high impedance voltmeter. Measurement is performed with all reference PICCs.

b) Measurement with 2 superimposed reference PICC

This test only applies to the slot-in type PCD.

Connect a jumper to resistor R3 of the reference PICC and adjust the resonance frequency to 19 MHz. (Adjust for the two reference PICCs used in testing.)

Place the reference PICCs in the operating range of the PCD while superimposed on each other and measure the voltage generated at both ends of R3 with a high impedance voltmeter.

Check for all combinations of reference PICCs.

(b) Measurements

The voltage generated at both ends of R3 is measured within the operating range of the PCD.

(c) Specifications

Receive voltage of reference PICC: 6.8 V or more

15.3.3 Modulation Waveform

This test measures the modulation factors, the rise and fall times, and overshoot values based on the waveform sent out by the PCD.

(1) Basic Specifications

(a) Test Method

Place the calibration coil in the operating magnetic field region of the PCD, observe the voltage waveform induced on the coil displayed on an oscilloscope screen, and measure the modulation factor and waveform characteristics.

(b) Measurements

The modulation waveform in the operating range of the PCD is measured, along with measurement of the modulation factor, rise time, fall time, and overshoot.

(c) Specifications

The modulation factor and modulation waveform shall satisfy the specifications of "9.1.2 Modulation".

(2) Extended Specifications

The modulation waveform is measured with the reference PICC is set in place.

(a) Test Method

Measure the modulation waveform on the calibration coil with the reference PICC placed within the operating range of the PCD.

Perform measurement using the reference PICC for modulation waveform testing specified in the extended specifications of "15.2.1 Reference PICC".

a) Measurement with a single reference PICC

The test method is as described below.

1) Adjust the reference PICC so as to synchronize at 19 MHz.
2) Place the calibration coil over the reference PICC coil, place the reference PICC in the operating range of the PCD, and measure the modulation waveform by monitoring the voltage waveform induced on the calibration coil.

b) Testing with 2 superimposed reference PICC

This test applies only to the slot-in type PCD. The test method is as described below.

1) Adjust the reference PICC so as to synchronize at 19 MHz. (Adjust for both reference PICCs used in testing.)
2) Place the calibration coil over the reference PICC coil with the two reference PICCs superimposed over each other, place the reference PICCs in the operating range of the PCD, and measure the modulation waveform by monitoring the voltage waveform induced on the calibration coil.

(b) Measurements

The modulation waveform in the operating range of the PCD is measured along with measurement of the modulation factor, rise time, fall time, and overshoot.

(c) Specifications

The degree of modulation and modulation waveform shall satisfy the specifications of "9.1.2 Modulation".

(3) References

None

15.3.4 Reception Ability of Load Modulation Signal

(1) Basic Specifications

(a) Test Method

This test verifies that the load modulation signal of the PICC is able to be properly demodulated by the PCD. The PCD is judged as being normal when it properly receives the subcarrier signal generated from the load modulation testing reference PICC .

Measure the load modulation signal reception ability of the PCD with the load modulation testing reference PICC specified in "15.2.1 Reference PICC".

This reference PICC is calibrated within the magnetic field strength generated by the test PCD so that conditions are not set ignoring various PCDs. This value shall be equal to the magnetic field strength generated by the actual PCD. The magnetic field generated by the PCD is measured using the calibration coil.

(b) Measurements

The load modulation signal that can be received by the PCD within the operating range of the PCD is measured.

(c) Specifications

The load modulation signal specified in "10.1.2 Load Modulation" must be able to be received within the operating range of the PCD.

(2) Extended Specifications

(a) Test Method

Measure with the load modulation testing reference PICC specified in the extended specifications of "15.2.1 Reference PICC".

Other parts of the test method are the same as the basic specifications.

(b) Measurements

The load modulation signal that can be received by the PCD within the operating range of the PCD is measured.

(c) Specifications

The load modulation signal specified in "10.1.2 Load Modulation" must be able to be received within the operating range of the PCD.

(3) References

None

16. External Communication Protocol

This clause specifies commands and responses that are required for realizing a proximity communication interface in the communication protocol between the PCD and an external device (to be referred to as an "upper device"). An external communication protocol that is capable of realizing both type A and type B communication formats on a single PCD is specified.

The anticollision processing method for type A PICC shall be the time slot method. The anticollision processing method for type B cards shall also be the time slot method.

With respect to the external communication protocol, the contents described in "16. External Communication Protocol" provided as reference specifications since this is not specified in ISO/IEC 14443.

16.1 Physical Interface

The specifications of the physical interface between the PCD and upper device are shown in "Table 16.1-1 Physical Interface Specifications".

Items in the table other than communication speed are fixed and cannot be changed. Details of the method for changing the communication speed are described in "16.5.3 (4) Changing Upper Communication Speed".

Table 16.1-1 Physical Interface Specifications

Item		Specifications
Signal level		RS-232C
Synchronization method		Half-duplex asynchronous
Flow control		None
Connector type (on PCD)		D-SUB9 pin (male)
Pin configuration (on PCD)		See "Table 16.1-2 Pin Configuration"
Character format (see "Fig. 16.1-1 Character Transmission Format")	Start bit	1 bit
	Data bits	8 bits (LSB first)
	Parity bit	Even parity
	Stop bit	1 bit
Communication speed		9600bps ~ 115200bps (initial value: 9600 bps)

The pin configuration of the connector of the PCD to which the external device is connected is shown in "Table 16.1-2 Pin Configuration".

Table 16.1-2 Pin Configuration

Pin no.	Signal	Input/output*	Meaning
1	CD	Input	(Not used)
2	RD	Input	Data received from upper device
3	SD	Output	Data sent to upper device
4	ER	Output	On (fixed)
5	SG	-	Signal ground
6	DR	Input	(Not used)
7	RS	Output	On (fixed)
8	CS	Input	(Not used)
9	RI	Input	(Not used)

* The direction of input and output in the table is the direction as viewed from the PCD.

The character transmission format is shown in "Fig. 16.1-1 Character Transmission Format".

	(LSB)							(MSB)		
Start	b1	b2	b3	b4	b5	b6	b7	b8	Parity	Stop

(transmitted first)

Fig. 16.1-1 Character Transmission Format

16.2Block Format

Communication between an upper device and PCD is performed in block units. Blocks are always sent by the upper device to the PCD first. Blocks sent from the upper device to the PCD are referred to as command blocks or commands.

When the PCD receives a command block from an upper device, it processes the command block and, as a general rule, returns the results to the upper device. Blocks sent from the PCD to the upper device are referred to as response blocks or simply as responses.

The format of command blocks and response blocks is shown in "Fig. 16.2-1 Block Format". Items surrounded by brackets "[ ]" in the figure indicate optioned items, and may not be transmitted depending on block contents. Items surrounded by parentheses "( )" in the figure represent the number of bytes for that item. Blocks are transmitted from left to right in the figure during block transmission.

RCB	LEN	[DAT]	BCC
(1)	(2)	(LEN)	(1)

Fig. 16.2-1 Block Format

16.2.1 RCB (Required)

RCB is a single byte of data that indicates the type of block transmitted. It indicates the type of command in command blocks sent from the upper device to the PCD, or, in a response block returned to the upper device from the PCD, indicates the receive state of the command block received immediately before .

RCB encoding and its contents are shown in "Table 16.2-1 Upper Device to PCD" and "Table 16.2-2 PCD to Upper Device".

Table 16.2-1 Upper Device to PCD

b8	b7	b6	b5	b4	b3	b2	b1	Description
0	0	-	-	-	-	-	-	Command for PICC (DAT portion sent to PICC)
0	1	-	-	-	-	-	-	Command for PCD (DAT portion processed with PCD)
1	-	-	-	-	-	-	-	Request to resend response (request to resend immediately prior response. The contents of the DAT portion are ignored)

Dashes "-" are retained for future specification and have a value of '0'.

Table 16.2-2 PCD to Upper Device

b8	b7	b6	b5	b4	b3	b2	b1	Description
0	-	-	-	-	-	-	-	Normal command reception
1	-	-	-	-	-	0	0	Character receive error (parity error, framing error, overrun, etc.)
1	-	-	-	-	-	0	1	CWT error (insufficient data received)
1	-	-	-	-	-	1	0	Receive buffer overflow
1	-	-	-	-	-	1	1	BCC error

Dashes "-" are retained for future specification and have a value of '0'.

16.2.2 LEN (Required)

LEN consists of two bytes of data that indicate the size of the DAT portion in a transmitted block. LEN has a value of 0000h to 0103h, and the upper byte is transmitted first.

When the PCD receives a command block from an upper device, the first three bytes are received as RCB and LEN. Next, data of the number of bytes indicated with LEN is read as DAT, and the next byte is processed as BCC.

If BCC is judged as normal, the contents of the received command block are interpreted and processing is carried out.

If the value of LEN in a command block is greater than the actual size of the DAT portion, the PCD judges that the data has been interrupted during the course of receiving. When this happens, the PCD shall return a response block indicating a CWT error to the upper device.

In addition, in the case the value of LEN is 0104h or more and the length of the DAT portion actually received is 0104h or more, the amount of received data may overflow from the receive buffer of the PCD. When this happens, PCD shall return a response block indicating a receive buffer overflow error to the upper device.

16.2.3 DAT (Optional)

DAT is data of variable length that indicates the main body of a command or response. Details of DAT encoding are defined in "16.5 Commands and Responses".

DAT is optional and there are blocks that do not contain DAT. Blocks without DATs are, resend response request blocks character receive error blocks, CWT error blocks, receive buffer overflow blocks and BCC error blocks. B8 of RCB is set to '1' in these blocks. (For details, refer to "16.2.1 RCB (Required)".

16.2.4 BCC (Required)

BCC is a single byte of data that indicates the block check code. The value of BCC is encoded so that the bitwise exclusive OR with RCB will result in a valie of 00h.

If the result of calculating BCC is other than 00h, the PCD judges that receiving of the command block has failed. When this happens, the PCD sends a response block indicating a BCC error to the upper device.

16.3Communication Time Specifications

Specification of the maximum delay time between characters within a block (character waiting time, CWT) is shown in "Fig. 16.3-1 Timing Between Characters" with respect to specification of the communication time between an upper device and PCD.

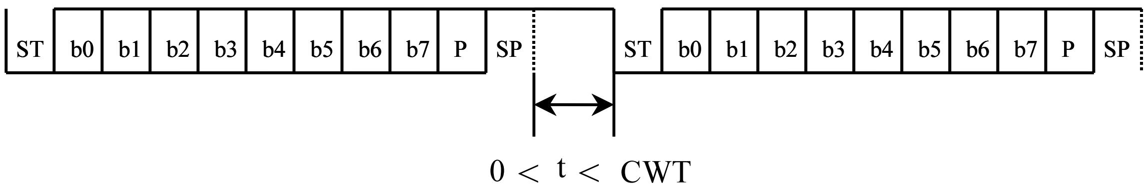


Fig. 16.3-1 Timing Between Characters

In addition, specification of block guard time (BGT) and specification of block waiting time (BWT) are shown in "Fig. 16.3-2 Timing Between Blocks".

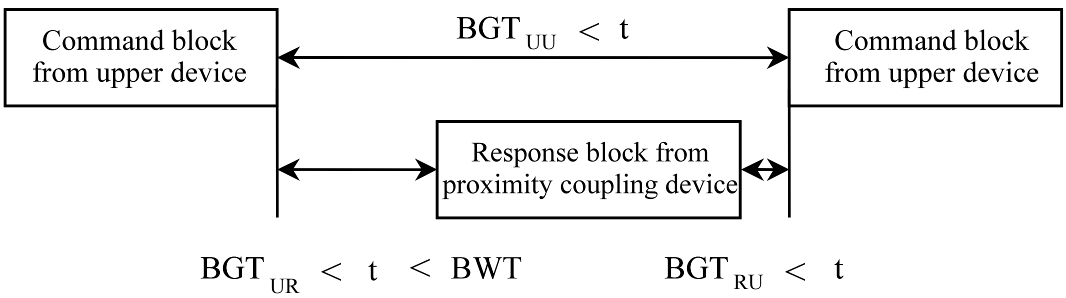


Fig. 16.3-2 Timing Between Blocks

16.3.1 Character Waiting Time (CWT)

The maximum delay time between two consecutive characters within a single block is shown in "Table 16.3-1 Character Waiting Time (CWT)". If the amount of time between two consecutive characters while receiving a block exceeds CWT, an inter-character timeout occurs.

If the PCD detects an inter-character timeout while receiving a command block from an upper device, it returns a CWT error block to the upper device.

Recommended processing when the upper device detects an inter-character timeout while receiving a response block from the PCD consists of interrupting the receive processing and sending a resend request block .

Table 16.3-1 Character Waiting Time (CWT)

Symbol	Maximum time (ms)
CWT	50

The minimum delay time between characters is 0 ms.

16.3.2 Block Guard Time (BGT)

Block guard time (BGT) is the shortest amount of time between two consecutive blocks along the transmission path between an upper device and PCD. If the next block is transmitted before BGT has elapsed, that block is not guaranteed.

The following three types of BGT are defined.

- BGT_{UR}: Shortest amount of time until the PCD sends a response block in response to a command block from an upper device
- BGT_{RU}: Shortest amount of time until an upper device sends a command block in response to a response block from the PCD
- BGT_{UU}: Shortest amount of time to send command blocks consecutively from an upper device. These specifications are not applied in cases where a response block from the PCD is present between consecutive command blocks. (See "16.4.1 (6) Consecutive Command Receive Error")

The value of each BGT is shown in "Table 16.3-2 Block Guard Time (BGT)".

Table 16.3-2 Block Guard Time (BGT)

Symbol	Minimum time (ms)
BGT_{UR}	1
BGT_{RU}	1
BGT_{UU}	CWT + 10 or BWT_{UR}, whichever is longer

16.3.3 Block Waiting Time (BWT)

The maximum waiting time until a response block from the PCD is started to be received following completion of transmission of a command block from an upper device is shown in "Table 16.3-3 Block Waiting Time (BWT)". If the amount of time until the start of block receiving exceeds BWT, an inter-block timeout occurs. Refer to "16.4.2(3) Receive Timeout (BWT)" for information on processing when the upper device detects an iner-block timeout.

BWT can have three types of values depending on the type of RCB of the command block sent from the upper device.

Table 16.3-3 Block Waiting Time (BWT)

Symbol	Conditions	Maximum time (ms)
BWT	Command for PICC	Transmission time to PICC + maximum receive waiting time of PICC + receive time from PICC + 10
	Command for PCD	500
	Resend response request	10

The maximum waiting time until the start of receiving of a command block from an upper device following completion of sending a response block by the PCD is not specified.
(The PCD does not monitor the waiting time of command blocks.)

16.4Communication Error Processing

Processing by the PCD and processing by the upper device when an error occcurs during communication between the upper device and PCD are as described below.

16.4.1 PCD Communication Error Processing

The processing of the PCD when a receive error occurs in the PCD is as described below.

(1) Character Receive Error

If there is an error in a character received by the PCD (such as a parity error, framing error or overrun), a character receive error occurs.

If the PCD has succesfully received data through LEN, a character receive error block is returned to the upper device following reception through BCC. If a character receive error occurs during reception of RCB or LEN, the PCD treats this as receiving noise, discards the portion it has received up to that point, and repeats reception from the beginning.

(2) CWT Error

If an inter-character timeout occurs while there is data still remaining to be received, a CWT error occurs. If the PCD has succesfully received data through LEN, an CWT error block is immediately returned to the upper device. If the an error occurred prior to receiving LEN, the PCD treats this as receiving noise and repeats reception from the beginning.

(3) Receive Buffer Overflow

If the data received exceeds the capacity of the receive buffer of the PCD, a receive buffer overflow occurs. When a receive buffer overflow occurs, the PCD discards all received data and immediately returns a receive buffer overflow block to the upper device.

(4) BCC Error

The PCD performs a BCC check after receiving data through BCC. If the calculated value of BCC is in error (other than 00h), a BCC error occurs. When a BCC error occurrs, the PCD discards all received data and immediately returns a BCC error block to the upper device.

(5) Received Data Amount Error

If additional data is received after receiving data through BCC, a received data amount error occurs. When a received data amount error occurs, the PCD performs processing ignoring all the data received after the error. Namely, processing for the received command block is performed if the contents of that command block are normal.

However, the operation of the PCD is not guaranteed when consecutive data is received by the PCD beyond BGT_{UR}.

(6) Consecutive Command Receive Error

Since communication between an upper device and the PCD is half-duplex, the upper device, as a general rule, sends the next command block after having received a response block from the PCD. However, there are cases in which the PCD does not return a response to the upper device for reasons such as a receive error in the PCD or while waiting for a response from a PICC.

In such cases, if a command block is sent from the upper device on or after BGT_{UU}, the PCD discontinues processing up to that point and performs processing for receiving a new command block. The PCD only sends a response block in response to a new command block and will not send a response block for the processing that was discontinued.

If the PCD receives data prior to BGT_{UU}, a consecutive command receive error occurs. The operation of the PCD is not guaranteed when a consecutive command receive error occurrs.

16.4.2 Upper Device Communication Error Processing

The recommended processing by an upper device when a communication error has been detected in the upper device is as described below.

(1) Receive Error

If some type of error is detected in a response block received from a PCD (such as a character receive error, CWT error or BCC error), a receive error occurs.

If a receive error has been detected in the upper device, a resend response request block is sent to the PCD. When the PCD receives this block, it resends the latest response block that was sent.

If a receive error is detecte again in the response to resend response request block, the manager of the upper device shall verify the communication line since there is the possibility of an error in the communication line between the upper device and PCD.

(2) Error Response Received

If a response received from the PCD is a block that indicates a command block receive error in the PCD (character receive error block, CWT error block or BCC error block), an error response receival occurs.

When an error resonse receival is detected in the upper device, the same as the command block previously sent is resent to the PCD is resended.

If a response error is detected again in response to the resent command, the manager of the upper device shall verify the communication line since there is the possibility of an error in the communication line between the upper device and PCD.

(3) Receive Timeout (BWT)

If there is no response from the PCD after BWT has elapsed, a receive timeout (BWT) error occurs.

When a receive timeout (BWT) is detected in the upper device, the following processing is performed according to the type of RCB of the command block that was sent.

- If a command for a PICC was sent:
  A PICC communication error is assumed to have occurred, and a command is resent according to the protocol of the PICC.
  Refer to "13. Transmission Protocol" for details regarding the procedure for resending commands to a PICC.

- If a command for the PCD was sent:
  There is the possibility that communication itself may not have been possible. If a receive timeout occurrs again after resending the command, check whether or not the power supply to the PCD is normal, and whether an anomaly has occurred in the communication line.
  (In the case of a PCD self-diagnostic command, since specifications are such that a response block is not returned from the PCD, detection of a receive time out (BWT) must not be performed by the upper device.)

- If a resend request response was sent:
  There is the possibility that communication itself may not have been possible. If a receive timeout occurrs again after resending the command, check whether or not the power supply to the PCD is normal, and whether an anomaly has occurred in the communication line.

16.5Commands and Responses

Commands are divided into commands for a PICC, commands for the PCD, and resend response request according to the value of RCB. The following provides a description of commands for PICC and commands for PCD along with their responses.

16.5.1 Commands and Response for PICC

If the value of b8 and b7 of RCB of a command block sent from an upper device is 0, the command is for a PICC.

When the case the PCD has normally received a command for a PICC, processing is performed according to the procedure described below.

1) The DAT portion of the received command block is set in a buffer for sending to the PICC.
2) The data in the buffer is sent to the PICC according to the communication frame format with the PICC.
3) A response from the PICC is awaited .
4) When a response is received from the PICC, only the data is extracted from the communication frame and set in the receive buffer.
5) The contents of the receive buffer are set in the DAT portion of the response block.
6) RCB, LEN and BCC are calculated, and a response block is sent to the upper device.

When communicating with a PICC using a command for a PICC, the precautions described below must be taken in the upper device.

- Prior to starting communication with the PICC, the carrier output from the PCD shall be turned on with a command for the PCD (carrier control command: see "16.5.3 (5) Carrier Control" for details).

- Communication conditions between the PCD and PICC are set with a command for the PCD (PICC communication information setting command: see "16.5.3 (6) PICC Communication Information Setting " for details).

- If CRC is used in communication with a PICC, since CRC is not calculated in the PCD, the CRC that will be sent to the PICC shall be embedded in advance in the DAT portion of the command for a PICC. In addition, the CRC received from the PICC shall also be contained in the response block.

- The PCD waits for a response from the PICC until a response is detected from the PICC. Consequently, if there is no response from the PICC, the PCD does not return a response block to the upper device.

- If the PCD detects an error when receiving a command from an upper device, it returns a receive error response block to the upper device without sending the DAT portion to the PICC.

The initial values of communication settings between the PCD and PICC are shown in "Table 16.5-1 PICC Communication Setting Initial Values".

Table 16.5-1 PICC Communication Setting Initial Values

Item	Initial value
PICC type	Type B
Communication speed (PCD to PICC)	106 kbps
Communication speed (PICC to PCD)	106 kbps

Processing when the PCD detects a communication error while receiving a response from the PICC is shown in "Table 16.5-2 Error Processing when Receiving Response from PICC".

Table 16.5-2 Error Processing when Receiving Response from PICC

Status	Processing
Character receive error prior to normal character reception	Treated as reception of noise and reception is continued.
Character receive error after normal character reception	Reception terminated and portion received normally sent to upper device.
Receive buffer overflow (FSD)	Reception termination through FSD and received portion sent to upper device.
(CRC error)	CRC error does not occur since CRC check not performed.
(FWT error)	FWT error does not occur since FWT monitoring not performed

16.5.2 Summary of Commands and Responses for PCD

(1) Summary of Commands for PCD

If b8 of RCB is 0 and b7 is 1, processing is performed as command for the PCD.

The format of the DAT portion of command blocks in commands for the PCD is shown in "Fig. 16.5-1 Command DAT Portion Format". Each item of the DAT portion is sent from left to right when sending commands.

Items surrounded by brackets "[ ]" in the figure refer optional items, and may not be added depending on the command. Items surrounded by parentheses "( )" represent the number of bytes of that item.

CLA	INS	P1	P2	[Lc]	[Data]	[Le]
(1)	(1)	(1)	(1)	(1)	(Lc)	(1)

Fig. 16.5-1 Command DAT Portion Format

In addition, the meaning of each item in the DAT portion block within a command block in commands for the PCD is shown in "Table 16.5-3 Meanings of Items".

Table 16.5-3 Meanings of Items

Item	Meaning
CLA	Command layer. Value is fixed at 00h (other values are retained for future specification).
INS	Command type. Details are shown in "Table 16.5-4 List of INS".
P1	Parameter 1 corresponding to INS.
P2	Parameter 2 corresponding to INS.
Lc	Length of data portion (optional*)
Data	Main body of data sent by PCD (optional*)
Le	Expected length of response data if data length of a response is designable (optional*)

* Items indicated as being optional may not be added depending on the command.

The correlation between INS values and commands is shown in "Table 16.5-4 List of INS".

Table 16.5-4 List of INS

Value	Command name	Section
01h	PCD Reset	16.5.3 (1) PCD Reset
03h	PCD Information Acquisition	16.5.3 (2) PCD Information Acquisition
05h	PICC Communication Information Acquisition	16.5.3 (3) PICC Communication Information Acquisition
07h	Changing Upper Communication Speed	16.5.3 (4) Changing Upper Communication Speed
11h	Carrier Control	16.5.3 (5) Carrier Control
13h	PICC Communication Information Setting	16.5.3 (6) PICC Communication Information Setting
21h	Request All A	16.5.3 (7) Request All A
23h	Select A	16.5.3 (8) Select A
25h	Request for ATS	16.5.3 (9) Request for ATS
27h	Parameter Change	16.5.3 (10) Parameter Change
29h	Halt A	16.5.3 (11) Halt A
31h	Request All B	16.5.3 (12) Request All B
33h	Attribute	16.5.3 (13) Attribute
39h	Halt B	16.5.3 (14) Halt B
3Bh	Wake-up All B	16.5.3 (15) Wake-up All B
F1h	PCD Self-Diagnosis	16.5.3 (16) PCD Self-Diagnosis
Other	(Retained for future specification)	

(2) Summary of Responses for PCD

The format of the DAT portion of response blocks in response to commands for the PCD is shown in "Fig. 16.5-2 Response DAT Portion Format". Each item of the DAT portion is sent from left to right when sending a response.

Items surrounded by brackets "[ ]" in the figure refer to optional items, and may not be added depending on the response. Items surrounded by parentheses "( )" represent the number of bytes of that item.

[Data]	SW1	SW2
(fixed value or Le)	(1)	(1)

Fig. 16.5-2 Response DAT Portion Format

In addition, the meaning of each item in the DAT portion block of a response block in response to commands for the PCD is shown in "Table 16.5-5 Meanings of Items".

Table 16.5-5 Meanings of Items

Item	Meaning
Data	Data obtained as a result of executing a command. The length of the data portion is either the value specified by a command or the value indicated with Le in a command (optional*).
SW1	Status word 1. Details of encoding of SW1 are shown in "Table 16.5-6 List of SW".
SW2	Status word 2. Details of encoding of SW2 are shown in "Table 16.5-6 List of SW".

* Items indicated as being optional may not be added depending on the response.

The possible values of SW1 and SW2 along with their meanings are shown in "Table 16.5-6 List of SW".

Table 16.5-6 List of SW

SW1	SW2	Meaning
90	00	Normal termination
62	00	Warning
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
69	00	Command not allowed
6B	00	P1, P2 error
6D	00	INS not supported
6E	00	CLA not supported
6F	00	Self-diagnosis error

Although the list of SW indicates all combinations of SW1 and SW2 that can be used in a response by the PCD, depending on the command, there are some SW that are not generated according to a command. (For details, refer to "16.5.3 Details of Commands and Responses for PCD".)

16.5.3 Details of Commands and Responses for PCD

(1) PCD Reset

(a) Operation

The state of the PCD is initialized.
Initialized items are as shown in "Table 16.5-7 Initialized Items". (The upper communication speed is not initialized.)

Table 16.5-7 Initialized Items

Item	Initial value
Carrier control	carrier output off
PICC type	Type B
Communication speed (PCD to PICC)	106 kbps
Communication speed (PICC to PCD)	106 kbps

(b) Command Format

The command format of PCD reset is shown in "Fig. 16.5-3 Command Format". Values represented in the form of xxh of each item in the figure indicate encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	01h	00h	00h
(1)	(1)	(1)	(1)

Fig. 16.5-3 Command Format

Other values of P1 and P2 are retained for future specification.

(c) Response Format

The response format of PCD reset is shown in "Fig. 16.5-4 Response Format". The values in parentheses "( )" in the figure indicate the number of bytes.

SW1	SW2
(1)	(1)

Fig. 16.5-4 Response Format

(d) Status

The values of status (SW1-SW2) in the response of PCD reset are shown in "Table 16.5-8 Status".

Table 16.5-8 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(2) PCD Information Acquisition

(a) Operation

Specific information of the PCD is acquired.

Items that can be acquired are as shown in "Table 16.5-9 PCD Information".

Table 16.5-9 PCD Information

Item	No. of bytes	Description
Specification no.	1	Specification no. with which the PCD complies. This number is to be 01h if it complies with this specification.
No. of send/receive buffers	1	No. of send and receive buffers of the PCD. Refer to "Fig. 16.5-5 Send/Receive Buffer Coefficients" and "Table 16.5-10 Buffer Coefficient and Buffer Number Correlation Chart" for encoding details.
PICC communication speed	1	Ability of the PCD to accommodate communication speed for the PICC. Refer to "Table 16.5-11 Communication Speeds Supported by PCD" for encoding details.
Type B options	1	Ability to execute options relating to type B communication frames. Refer to "Fig. 16.5-6 Encoding of Type B Options", "Table 16.5-12 Accommodation of Omission of SOF/EOF", "Table 16.5-13 Minimum Value of Subcarrier Non-Modulation Period" and "Table 16.5-14 Minimum Value of Subcarrier Preamble" for encoding details.
Upper communication speed no.	1	Number of bytes of upper communication speed (value of 1 or 2)
Upper communication speed	1 ~ 2	Supported upper communication speed. Maximum communication speed = Basic communication speed x 2_n Upper 4 bits: Basic communication speed (0: 9600 bps, 1: 14400 bps, other: retained for future specification) Lower 4 bits: Maximum communication speed multiplier n Example) 02h: Supports 9600/19200/38400 bps, 13h: supports 14400/28800/57600/115200 bps
Manufacturer's characteristic data no.	1	Number of bytes of manufacturer specific data.
Manufacturer specific data	0 ~ 8	Number of bytes of PCD manufacturer specific data. Maximum of 8 bytes. Can be used arbitrarily by PCD manufacturers.

The number of send/receive buffers is indicated using buffer coefficients. The encoding format of send/receive buffer coefficients is shown in "Fig. 16.5-5 Send/Receive Buffer Coefficients".

b8	b7	b6	b5	b4	b3	b2	b1
Send buffer coefficient				Receive buffer coefficient			

Fig. 16.5-5 Send/Receive Buffer Coefficients

The correlation between buffer coefficients and the number of buffers is shown in "Table 16.5-10 Buffer Coefficient and Buffer Number Correlation Chart".

Table 16.5-10 Buffer Coefficient and Buffer Number Correlation Chart

Buffer coefficient	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'	'8'	'9' - 'F'
Buffer (bytes)	16	24	32	40	48	64	96	128	256	Retained for future specification

The PICC communication speed indicates the ability of the PCD to accommodate the PICC communication speed by using the format shown in "Table 16.5-11 Communication Speeds Supported by PCD".

Table 16.5-11 Communication Speeds Supported by PCD

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
0	0	0	0	0	0	0	0	PCD only supports 106 kbps in bi-directional transmission
1	-	-	-	0	-	-	-	Bi-directional transmission speed forced to be the same
-	-	-	1	0	-	-	-	Supports 212 kbps transmission speed from PICC to PCD
-	-	1	-	0	-	-	-	Supports 424 kbps transmission speed from PICC to PCD
-	1	-	-	0	-	-	-	Supports 847 kbps transmission speed from PICC to PCD
-	-	-	-	0	-	-	1	Supports 212 kbps transmission speed from PCD to PICC
-	-	-	-	0	-	1	-	Supports 424 kbps transmission speed from PCD to PICC
-	-	-	-	0	1	-	-	Supports 847 kbps transmission speed from PCD to PICC

Encoding of type B options is shown in "Fig. 16.5-6 Encoding of Type B Options".

b8	b7	b6	b5	b4	b3	b2	b1
Minimum value of subcarrier non-modulation period		Minimum value of subcarrier preamble		EOF omission accomodation	SOF omission accomodation	Retained for future specification	

Fig. 16.5-6 Encoding of Type B Options

The relationship between values and meanings for accommodation of omission of SOF/EOF is shown in "Table 16.5-12 Accommodation of Omission of SOF/EOF".

Table 16.5-12 Accommodation of Omission of SOF/EOF

b3	SOF omission accomodation
0	No
1	Yes

b4	EOF omission accomodation
0	No
1	Yes

The relationship between the values and meanings for the minimum value of the subcarrier non-modulation period is shown in "Table 16.5-13 Minimum Value of Subcarrier Non-Modulation Period".

Table 16.5-13 Minimum Value of Subcarrier Non-Modulation Period

b8-b7	Minimum value of subcarrier non-modulation period
00	64 / fs
01	48 / fs
10	16 / fs
11	Retained for future specification

The relationship between the values and meanings for the minimum value of the subcarrier preaamble is shown in "Table 16.5-14 Minimum Value of Subcarrier Preamble".

Table 16.5-14 Minimum Value of Subcarrier Preamble

b6-b5	Minimum value of subcarrier preamble
00	80 / fs
01	64 / fs
10	16 / fs
11	Retained for future specification

(b) Command Format

The command format of PCD information acquisition is shown in "Fig. 16.5-7 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	03h	00h	00h
(1)	(1)	(1)	(1)

Fig. 16.5-7 Command Format

Other values of P1 and P2 are retained for future specification.

(c) Response Format

The response format of PCD information acquisition is shown in "Fig. 16.5-8 Response Format". Values in parentheses "( )" in the figure indicate the number of bytes.

Data	SW1	SW2
(7~16)	(1)	(1)

Fig. 16.5-8 Response Format

The contents of the data portion are as shown in "Table 16.5-9 PCD Information". The order of sending is the order in which the items are shown, starting with specification number followed by no. of send/receive buffers and ending with manufacturer specific data. However, in the case the manufacturer's specific data number is 00h, there is no manufacturer specific data.

If the contents of status as indicated with SW1 and SW2 are that other than normal termination, the data portion is not present in the response.

(d) Status

The values of status (SW1-SW2) in the response of PCD information acquisition are shown in "Table 16.5-15 Status".

Table 16.5-15 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(3) PICC Communication Information Acquisition

(a) Operation

The current PICC communication setting information of the PCD is acquired.
Items that can be acquired are as shown in "Table 16.5-16 PICC Communication Information".

Table 16.5-16 PICC Communication Information

Item	No. of bytes	Description
PICC type	1	00h: Type B, 01h: Type A time slot type. Other values are retained for future specification.
PICC communication speed	1	Encoding details are shown in "Fig. 16.5-9 Encoding of PICC Communication Speed" and "Table 16.5-17 Communication Speed Coefficient and Communication Speed Correlation Chart".

Encoding of PICC communication speed is shown in "Fig. 16.5-9 Encoding of PICC Communication Speed".

b8	b7	b6	b5	b4	b3	b2	b1
(0000)b Other values are retained for future specification.				Communication speed coefficient from PICC to PCD		Communication speed coefficient from PCD to PICC	

Fig. 16.5-9 Encoding of PICC Communication Speed

The correlation between communication speed coefficient and communication speed is shown in "Table 16.5-17 Communication Speed Coefficient and Communication Speed Correlation Chart".

Table 16.5-17 Communication Speed Coefficient and Communication Speed Correlation Chart

Communication speed coefficient	'0'	'1'	'2'	'3'
Communication speed (bytes)	106 kbps	212 kbps	424 kbps	847 kbps

(b) Command Format

The command format of PCD information acquisition is shown in "Fig. 16.5-10 Command Format". Values indicated in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	05h	00h	00h
(1)	(1)	(1)	(1)

Fig. 16.5-10 Command Format

Other values of P1 and P2 are retained for future specification.

(c) Response Format

The response format of PCD information acquisition is shown in "Fig. 16.5-11 Response Format". Values in parentheses "( )" in the figure indicate the number of bytes.

Data	SW1	SW2
(2)	(1)	(1)

Fig. 16.5-11 Response Format

The contents of the data portion are as shown in "Table 16.5-16 PCD Information". The order of sending is the order in which the items are shown, starting with PICC type followed by PICC communication speed.

If the contents of status as indicated with SW1 and SW2 are that other than normal termination, the data portion is not present in the response.

(d) Status

The values of status (SW1-SW2) in the response of PICC information acquisition are shown in "Table 16.5-18 Status".

Table 16.5-18 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(4) Changing Upper Communication Speed

(a) Operation

The communication speed between the PCD and an upper device is changed. Communication speeds that can be set are the supported communication speeds obtained with the PCD information acquisition command.

Conditions for changing the PCD to the set communication speed are only when SW1-SW2 are 9000h. In addition, the communication speed of the PCD can only be changed within BGT_{RU} after sending a response.

(b) Command Format

The command format for changing upper communication speed is shown in "Fig. 16.5-12 Command Format". Values represented in the form of xxh of each item in the figure indicate the encoding of that item, and values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	07h		00h
(1)	(1)	(1)	(1)

Fig. 16.5-12 Command Format

The value of P1 indicates the communication speed that is set. Encoding of P1 is as shown in "Table 16.5-19 Encoding of Upper Communication Speed", and undefined values are retained for future specification.

The value of P2 is fixed at 00h, and other values are retained for future specification.

Table 16.5-19 Encoding of Upper Communication Speed

Upper 4 bits	Basic communication speed
0	9600 bps
1	14400 bps

Lower 4 bits	Communication speed multiplier
n	2^n

Upper communication speed = Basic communication speed x Communication speed multiplier

(c) Response Format

The response format for changing upper communication speed is shown in "Fig. 16.5-13 Response Format". Values in parentheses "( )" in the figure indicate the number of bytes.

SW1	SW2
(1)	(1)

Fig. 16.5-13 Response Format

(d) Status

The values of status (SW1-SW2) in the response for changing upper communication speed are shown in "Table 16.5-20 Status".

Table 16.5-20 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(5) Carrier Control

(a) Operation

This command controls the on/off state of carrier output from the PCD. States that can be set relating to carrier control are shown in "Table 16.5-21 Carrier States".

Table 16.5-21 Carrier States

Setting	P1
Carrier output off	00h
Carrier output on	01h

(b) Command Format

The command format of carrier control is shown in "Fig. 16.5-14 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of each item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	11h		00h
(1)	(1)	(1)	(1)

Fig. 16.5-14 Command Format

The values of P1 are as shown in "Table 16.5-21 Carrier States". Furthermore, other values of P1 are retained for future specification.

The value of P2 is fixed at 00h, and other values are retained for future specification.

(c) Response Format

The response format of carrier control is shown in "Fig. 16.5-15 Response Format". Values in parentheses "( )" in the figure indicate the number of bytes.

SW1	SW2
(1)	(1)

Fig. 16.5-15 Response Format

(d) Status

The values of status (SW1-SW2) in the response of carrier control are shown in "Table 16.5-22 Status".

Table 16.5-22 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(6) PICC Communication Information Setting

(a) Operation

Communication information of the PCD for the PICC is set. Items that can be set are shown in "Table 16.5-23 PICC Information".

Table 16.5-23 PICC Information

Item	Parameter	Description
PICC type	P1	00h: Type B, 01h: Type A time slot type. Other values are retained for future specification.
PICC communication speed	P2	Encoding details are shown in "Fig. 16.5-9 Encoding of PICC Communication Speed" and "Table 16.5-17 Communication Speed Coefficient and Communication Speed Correlation Chart".

(b) Command Format

The command format of PICC communication information setting is shown in "Fig. 16.5-16 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA 00h	INS 13h	P1	P2
(1)	(1)	(1)	(1)

Fig. 16.5-16 Command Format

The values of P1 and P2 are as shown in "Table 16.5-23 PICC Information". However, in the case the PICC type is type A, modulation format from the PCD may show anomaly at PICC communication speeds of 212, 424 and 847 kbps, hence those settings are prohibited. Furthermore, other values of P1 and P2 are retained for future specification.

(c) Response Format

The response format of PICC communication information setting is shown in "Fig. 16.5-17 Response Format". Values in parentheses "( )" in the figure indicate the number of bytes.

SW1	SW2
(1)	(1)

Fig. 16.5-17 Response Format

(d) Status

The values of status (SW1-SW2) in the response of PICC communication information setting are shown in "Table 16.5-24 Status".

Table 16.5-24 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(7) Request All A

(a) Operation

A single REQA_t command and REQ-ID command is sent to a type A PICC from a PCD and a returned unique identifier (UID) of a PICC in a normally received ATQ-ID is sent to an upper device. If the UID was not received normally from the PICC, only the collision detection result is returned to the upper device.

(Refer to "12.5 Type A Timeslot - Initialization and Anticollision" for details regarding REQA_t and REQ-ID.)

When executing this command, parameters are set to the type A time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of request all A is shown in "Fig. 16.5-18 Command Format". Values represented in the form of xxh of each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	21h		
(1)	(1)	(1)	(1)

Fig. 16.5-18 Command Format

The values of P1 and P2 are the same as P1 and P2 of the REQ-ID command sent to the type A PICC.

(c) Response Format

The response format of request all A is shown in "Fig. 16.5-19 Response Format". The values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-19 Response Format

The format of the data portion in a response block is shown in "Fig. 16.5-25 Data Portion Format". The order of transmission is the same as the order in which the items are shown.

Fig. 16.5-25 Data Portion Format

Item	No. of bytes	Description
Collision detection	1	00h: No collision, 01h: Collision, Other: Retained for future specification
No. of UID received	1	Number of UIDs normally received
Received UID1	8	First UID normally received
…	…	…
Received UIDn	8	nth UID normally received

If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of request all A are shown in "Table 16.5-26 Status".

Table 16.5-26 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(8) Select A

(a) Operation

A SEL_t command is sent to a type A PICC, and the received SAK_t response is sent to an upper device.

(Refer to "12.5 Type A Timeslot - Initialization and Anticollision" for details regarding SEL_t.)

When executing this command, the parameters are set to the type A time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of select A is shown in "Fig. 16.5-20 Command Format". Values represented in the form of xxh of each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2	Lc	Data
00h	23h	CID	00h		Priximity IC card UID
(1)	(1)	(1)	(1)	(1)	(Lc)

Fig. 16.5-20 Command Format

P1 is the same as that of CID in the SEL_t command sent to the PICC.

The value of P2 is 00h, and other values are retained for future specification.

The value of Lc is the length of the data portion.

The data is the same as the UID in the SEL_t command sent to the PICC.

(c) Response Format

The response format of select A is shown in "Fig. 16.5-21 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-21 Response Format

The data portion is the SAK_t response received from the PICC (excluding CRC).
If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of Select A are shown in "Table 16.5-27 Status".

Table 16.5-27 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(9) Request for ATS

(a) Operation

A RATS command is sent to a type A PICC, and the received ATS response is sent to an upper device.
(Refer to "13.1 Type A Protocol Activation" for details regarding RATS.)
When executing this command, the parameters are set to the type A time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of select A is shown in "Fig. 16.5-22 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	25h	Param	00h
(1)	(1)	(1)	(1)

Fig. 16.5-22 Command Format

P1 is the same as that of Param portion in the RATS command sent to the PICC.
The value of P2 is 00h, and other values are retained for future specification.

(c) Response Format

The response format of ATS request is shown in "Fig. 16.5-23 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-23 Response Format

The data portion is the ATS response received from the PICC (excluding CRC).
If the status contents represented with SW1 and SW2 do not indcate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of ATS request are shown in "Table 16.5-28 Status".

Table 16.5-28 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(10) Parameter Change

(a) Operation

A PPS command is sent to a type A PICC, and the received response is sent to an upper device. (Refer to "13.1 Type A Protocol Activation" for details regarding PPS.)

When executing this command, the parameters are set to the type A time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format for parameter change is shown in "Fig. 16.5-24 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA 00h	INS 27h	P1 PPSS	P2 00h	Lc	Data PPS0, PPS1
(1)	(1)	(1)	(1)	(1)	(Lc)

Fig. 16.5-24 Command Format

P1 is the same as of the PPSS in the PPS command sent to the PICC.
The value of P2 is 00h, and other values are retained for future specification.
The value of Lc is the length of the data portion.
The data are PPS0 and PPS1 in the PPS command sent to the PICC.

(c) Response Format

The response format for parameter change is shown in "Fig. 16.5-25 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-25 Response Format

The data portion is the PPSS response received from the PICC (excluding CRC).

If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response for parameter change are shown in "Table 16.5-29 Status".

Table 16.5-29 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(11) Halt A

(a) Operation

A HALT_t command is sent to a type A PICC, and the received response is sent to an upper device. (Refer to "12.5 Type A Timeslot - Initialization and Anticollision" for details regarding HALT_t.) When executing this command, the parameters are set to the type A time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of halt A is shown in "Fig. 16.5-26 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	29h	CID	00h
(1)	(1)	(1)	(1)

Fig. 16.5-26 Command Format

P1 is the same as the CID of the destination PICC to which the HALT_t command is sent.
The value of P2 is 00h, and other values are retained for future specification.

(c) Response Format

The response format of halt A is shown in "Fig. 16.5-27 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-27 Response Format

The data portion is the response received from the PICC (excluding CRC).
If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of halt A are shown in "Table 16.5-30 Status".

Table 16.5-30 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(12) Request All B

(a) Operation

An REQB command is sent to a type B PICC, and the PUPI, application data and protocol information in the ATQB response of the PICC normally received using a time slot are sent to an upper device.
(Refer to "12.2 Type B - Initialization and Anticollison" for details regarding REQB.)
When executing this command, the parameters are set to the type B time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of request all B is shown in "Fig. 16.5-28 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	31h	AFI	Param
(1)	(1)	(1)	(1)

Fig. 16.5-28 Command Format

P1 is the same as the AFI in the REQB command sent to the PICC.
P2 is the same as the Param in the REQB command sent to the PICC.

(c) Response Format

The response format of request all B is shown in "Fig. 16.5-29 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-29 Response Format

The format of the data portion is shown in "Table 16.5-31 Data Portion Format".

Table 16.5-31 Data Portion Format

Item	No. of bytes	Description
Collision detection	1	00h: No collision, 01h: Collision, Other: Retained for future specification
No. of information received	1	Number of PICC of which the ATQB was normally received
Received information 1	11	First normally received information (PUPI, application data, protocol information)
…	…	…
Received information n	11	nth normally received information (PUPI, application data, protocol information)

If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of request all B are shown in "Table 16.5-32 Status".

Table 16.5-32 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(13) Attribute

(a) Operation

A ATTRIB command is sent to a type B PICC, and the received response is sent to an upper device.

(Refer to "12.2 Type B Initialization and Anticollision" for details regarding ATTRIB.)

When executing this command, the parameters are set to the type B time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of attribute is shown in "Fig. 16.5-30 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2	Lc	Data
00h	33h	00h	00h		ATTRIB
(1)	(1)	(1)	(1)	(1)	(Lc)

Fig. 16.5-30 Command Format

P1 and P2 are each fixed at 00h, and other values are retained for future specification.

Lc is the length of the data portion.

The data portion consists of the Identifier, Param 1, Param 2, Param 3, CID and Higher Layer INF in the ATTRIB command sent to the PICC.

(c) Response Format

The response format of attribute is shown in "Fig. 16.5-31 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-31 Response Format

The data portion is the response received from the PICC (excluding CRC).

If the status contents represented with SW1 and SW2 do not indicate normal terminarion, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of attribute are shown in "Table 16.5-33 Status".

Table 16.5-33 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(14) Halt B

(a) Operation

A HLTB command is sent to a type B PICC, and the received response is sent to an upper device. (Refer to "12.2 Type B Initialization and Anticollision" for details regarding HLTB.)

When executing this command, the parameters are set to the type B time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of halt B is shown in "Fig. 16.5-32 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2	Lc	Data
00h	39h	00h	00h		Identifier
(1)	(1)	(1)	(1)	(1)	(Lc)

Fig. 16.5-32 Command Format

P1 and P2 are each fixed at 00h, and other values are retained for future specification.

Lc is the length of the data portion.

The data portion is the Identifier in the HLTB command sent to the PICC.

(c) Response Format

The response format of halt B is shown in "Fig. 16.5-33 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-33 Response Format

The data portion is the response received from the PICC (and does not contain CRC).
If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of halt B are shown in "Table 16.5-34 Status".

Table 16.5-34 Status

SW1	SW2	Meaning
90	00	Normal termination
62	F0	PICC communication receive timeout
62	F1	PICC communication receive error
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(15) Wake-up All B

(a) Operation

An WUPB command is sent to a type B PICC, and the PUPI, application data and protocol information in the ATQB response of the PICC normally received using a time slot are sent to an upper device.

(Refer to "12.2 Type B Initialization and Anticollision" for details regarding WUPB.)

When executing this command, the parameters are set to the type B time slot type and a communication speed of 106 kbps regardless of the PICC communication settings. Following execution of this command, the PICC communication settings return to their original settings.

(b) Command Format

The command format of wake-up all B is shown in "Fig. 16.5-34 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA	INS	P1	P2
00h	3Bh	AFI	Param
(1)	(1)	(1)	(1)

Fig. 16.5-34 Command Format

P1 is the same as the AFI in the WUPB command sent to the PICC.

P2 is the same as the Param in the WUPB command sent to the PICC.

(c) Response Format

The response format of wake-up all B is shown in "Fig. 16.5-35 Response Format". Values in parentheses "( )" indicate the number of bytes.

Data	SW1	SW2
()	(1)	(1)

Fig. 16.5-35 Response Format

The format of the data portion is shown in "Table 16.5-35 Data Portion Format".

Table 16.5-35 Data Portion Format

Item	No. of bytes	Description
Collision detection	1	00h: No collision, 01h: Collision, Other: Retained for future specification
No. of information received	1	Number of PICC of which the ATQB was normally received
Received information 1	11	First normally received information (PUPI, application data, protocol information)
…	…	…
Received information n	11	nth normally received information (PUPI, application data, protocol information)

If the status contents represented with SW1 and SW2 do not indicate normal termination, a data portion is not present in the response.

(d) Status

The status (SW1-SW2) values in the response of wake-up all B are shown in "Table 16.5-36 Status".

Table 16.5-36 Status

SW1	SW2	Meaning
90	00	Normal termination
64	00	Execution error
67	00	Command length error
6B	00	P1, P2 error

(16) PCD Self-Diagnosis

(a) Operation

Self-diagnosis of the PCD is performed.

Items eligible for self-diagnosis are shown in "Table 16.5-37 Self-Diagnosis Items".

Table 16.5-37 Self-Diagnosis Items

Item	P1-P2	Description
Modulation data "0" output	0000h	Data modulated with data "0" is continuously output.
Modulation data "1" output	0001h	Data modulated with data "1" is continuously output.
Modulation data random output	0002h	Data modulated randomly is continuously output.

(b) Command Format

The command format of PCD self-diagnosis is shown in "Fig. 16.5-36 Command Format". Values represented in the form of xxh for each item in the figure indicate the encoding of that item, while values in parentheses "( )" indicate the number of bytes.

CLA 00h	INS F1h	P1	P2
(1)	(1)	(1)	(1)

Fig. 16.5-36 Command Format

The values of P1 and P2 are as shown in "Table 16.5-37 Self-Diagnosis Items". Other values of P1 and P2 are retained for future specification.

(c) Response Format

The PCD does not return a response when this command is executed.

16.6Reference Information

The communication sequence between an upper device and PCD is described here as reference information. In addition, communication between the PCD and PICC is also described as necessary.

16.6.1 Normal Communication Sequence Examples

Example of normal communication sequences are shown below.

(1) PCD Initialization

The sequence through initialization of the PCD and enabling of communication with the PICC is shown in "Fig. 16.6-1 Initialization Sequence".

Upper device		PCD
		(PCD power switched on)
PCD information acquisition command	→	
	←	PCD information acquisition response
Change upper communication speed command	→	
	←	Change upper communication speed response
(Communication speed changed)		(Communication speed changed)
Carrier control command (carrier output on)	→	(carrier output on)
	←	Carrier control response

Fig. 16.6-1 Initialization Sequence

(2) Type B PICC Detection (One Card)

The sequence for detecting a type B PICC where initialization of the PCD has been completed is shown in "Fig. 16.6-2 Type B PICC Detection Sequence 1" (case of one PICC).

Upper device		PCD		PICC
Request B command	→	REQB command	→	
		Slot-MARKER command (n - 1 times)	→	
	←	Request B response (no PICC)		
…		…		(PICC inserted)
Request B command	→	REQB command	→	
		Slot-MARKER command (n - 1 times)	→	
			←	ATQB response (1)
	←	Request B response (PICC 1)		
Attribute command (1)	→	ATTRIB command (1)	→	
	←	Attribute response (1)	←	Answer to ATTRIB response (1)

Fig. 16.6-2 Type B PICC Detection Sequence 1

The numbers in parentheses are the number of the PICC for the sake of convenience, and indicate that the information of the corresponding card is sent.

(3) Type B PICC Detection (Multiple Cards)

The sequence for detecting a type B PICC where initialization of the PCD has been completed is shown in "Fig. 16.6-3 Type B PICC Detection Sequence 2" (case of two PICC).

Upper device		PCD		PICC
Request B command	→	REQB command	→	
		Slot-MARKER command (n - 1 times)	→	
		[Collision]	←	ATQB response (1), (2)
	←	Request B response (collision)		
Request B command	→	REQB command	→	
		Slot-MARKER command (n - 1 times)	→	
		[No collision]	→ ←	ATQB response (1), (2)
	←	Request B response (PICC (1), (2))		
Attribute command (1)	→	ATTRIB command (1)	→	
	←	Attribute response (1)	←	Answer to ATTRIB response (1)
Attribute command (2)	→	ATTRIB command (2)	→	
	←	Attribute response (2)	←	Answer to ATTRIB response (2)

Fig. 16.6-3 Type B PICC Detection Sequence 2

The numbers in parentheses are the number of the PICC for the sake of convenience, and indicate that the information of the corresponding card is sent.

(4) Type A PICC Detection (Multiple Cards)

The sequence for detecting a type A PICC where initialization of the PCD has been completed is shown in "Fig. 16.6-4 Type A PICC Detection Sequence" (case of two PICC).

Upper device		PCD		PICC
Change PICC communication setting command (A)	→	(communication type: A)		
	←	Change PICC communication setting response		
Request A command	→	REQA_t command	→	
		REQ-ID command	→	
	←	Request A response (no PICC)		
…		…		
Request A command	→	REQA_tcommand	→	
			←	ATQA_t response (1), (2)
		REQ-ID command	→	
		[Collision]	←	ATQ-ID response (1), (2)
	←	Request A response (collision)		
Request A command	→	REQA_t command	→	
			←	ATQA_t response (1), (2)
		REQ-ID command	→	
		[No collision]	←	ATQ-ID response (1), (2)
	←	Request A response (PICC (1), (2))		
Select A command (1)	→	SEL_t command (1)	→	
	←	Select A response (1)	←	SAK response (1)
ATS request command (1)	→	RATS command (1)	→	
	←	ATS request response (1)	←	ATS response (1)
Change parameter command (1)	→	PPS command (1)	→	
	←	Change parameter response (1)	←	PPS response (1)

Fig. 16.6-4 Type A PICC Detection Sequence

Upper device		PCD		PICC
Select A command (2)	→	SEL_t command (2)	→	
	←	Select A response (2)	←	SAK response (2)
ATS request command (2)	→	RATS command (2)	→	
	←	ATS request response (2)	←	ATS response (2)
Change parameter command (2)	→	PPS command (2)	→	
	←	Change parameter response (2)	←	PPS response (2)

Fig. 16.6-4 Type A PICC Detection Sequence (continued)

The numbers in parentheses are the number of the PICC for the sake of convenience, and indicate that the information of the corresponding card is sent.

(5) PICC Deactivation

The sequence for deactivating a PICC where detection of the PICC has been completed is shown in "Fig. 16.6-5 PICC Deactivation Sequence 5".

Upper device		PCD		PICC
Command for PICC (DESELECT)	→	DESELECT command	→	
	←	Response for PICC (OK)	←	OK response ↓ (changes to HALT state)

Fig. 16.6-5 PICC Deactivation Sequence 5

16.6.2 Abnormal Communication Sequence Example

The following indicates communication sequences on event of an error.

(1) PCD Receive Error

The processing sequence when the PCD has judged a command received from an upper device to be a receive error is shown in "Fig. 16.6-6 PCD Receive Error Sequence".

Upper device		PCD
Command	→	(receive error)
	←	Receive error response
Command (resend)	→	(command processing)
	←	Response

Fig. 16.6-6 PCD Receive Error Sequence

(2) Upper Device Receive Error

The processing sequence when an upper device has judged a response received from the PCD to be a receive error is shown in "Fig. 16.6-7 Upper Device Receive Error Sequence ".

Upper device		PCD
Command	→	(command processing)
(receive error)	←	Response
Resend request command	→	
	←	Response (resend)

Fig. 16.6-7 Upper Device Receive Error Sequence

(3) Upper Communication Speed Change Error 1

The processing sequence when an upper device has judged a response received from the PCD to be a receive error during a change upper communication speed command is shown in "Fig. 16.6-8 Upper Communication Speed Change Error Sequence 1".

Upper device		PCD
Change upper communication speed command	→	(command processing)
(receive error)	←	Response
↓		↓
(Communication speed changed)		(Communication speed changed)
Resend request command	→	
	←	Response to resend

Fig. 16.6-8 Upper Communication Speed Change Error Sequence 1

If the upper device receives any response, it considers the PCD has performed processing normally and changes the communication speed.

(4) Upper Communication Speed Change Error 2

The processing sequence when the PCD has judged a command received from an upper device to be a receive error during a change upper communication speed command, and the upper device has judged a response received from the PCD to be a receive error is shown in "Fig. 16.6-9 Upper Communication Speed Change Error Sequence 2".

Upper device		PCD
Change upper communication speed command	→	(receive error)
(receive error)	←	Receive error response
↓		
(Communication speed changed)		
Resend request command	→	(receive error)
(receive error)	←	Receive error response
↓		
(Communication speed returned to original speed)		
Change upper communication speed command	→	(command processing)
(Normally received)	←	Response
↓		↓
(Communication speed changed)		(Communication speed changed)

Fig. 16.6-9 Upper Communication Speed Change Error Sequence 2

If the upper device receives any response, it considers the PCD has performed processing normally and changes the communication speed. If a receive error occurrs again when sending a request in response to the resend command, the communication speed returns to its original speed.

(5) PICC Communication Error 1

The processing sequence where the PCD has judged a response received from a PICC to be a receive error during a command for the PICC is shown in "Fig. 16.6-10 PICC Communication Error Sequence 1".

Upper device		PCD		PICC
Command for PICC	→	DAT portion sent to PICC	→	(command processing)
		(receive error)	←	Response
(Receive error from PICC)	←	Normally received portion sent as a response		
Resent according to sequence	→	DAT portion sent to PICC	→	(command processing)
	←	Response for PICC	←	Response

Fig. 16.6-10 PICC Communication Error Sequence 1

If the upper device has judged there was a receive error from the PICC, the command is resent according to the transmission sequence of the PICC.

(6) PICC Communication Error 2

The processing sequence where an upper device has judged that a timeout has occured waiting for a response from the PCD during a command for the PICC (caused by a receive error in the PICC) is shown in "Fig. 16.6-11 PICC Communication Error Sequence 2".

Upper device		PCD		PICC
Command for PICC	→	DAT portion sent to PICC	→	(receive error)
(waiting for duration of BWT)				
↓				
(transmission error to PICC)				
Resent according to sequence	→	DAT portion sent to PICC	→	(command processing)
	←	Response for PICC	←	Response

Fig. 16.6-11 PICC Communication Error Sequence 2

If the upper device has judged there is no response from the PICC, the command is resent according to the transmission sequence of the PICC.

(7) PICC Communication Error 3

The processing sequence where an upper device has judged that a timeout has occurred waiting for response from the PCD during a command for the PICC (caused by absence of the PICC) is shown in "Fig. 16.6-12 PICC Communication Error Sequence 3".

Upper device		PCD		PICC
Command for PICC	→	DAT portion sent to PICC	→	
(waiting for duration of BWT) ↓ (transmission error to PICC)				
Resent according to sequence	→	DAT portion sent to PICC	→	
(waiting for duration of BWT) ↓ (PICC judged to be absent, processing terminated)				

Fig. 16.6-12 PICC Communication Error Sequence 3

If the upper device has judged there is no response from the PICC and there is no response even after resending, it is judged to be absent according to the transmission sequence of the PICC.

17. Compatibility Test Method

The test method is specified for evaluating interoperability and compatibility of a PICC and PCD. In addition, the contents of evaluation by cross-testing the PICC and PCD are also specified.

(1) Verification Levels

Verification levels are shown in "Table 17-1 Compatibility Test Levels".

Table 17-1 Compatibility Test Levels

No	Verification level	Verified contents	Evaluation
1	Signal level	Send commands from the PCD and monitor the response from the card at the receive signal level of the PCD based on "9. Communication PCD to PICC" and "10. Communication PICC to PCD".	Evaluated as being compatible if the response from the card is at a level that can be received with the PCD.
2	Polling	Verify the response from the card in response to an REQ command from the PCD based on "11. Polling".	Evaluated as being compatible if the response from the card can be received with the PCD.
3	Anticollision	Detect one or two cards based on "12. Anticollision".	Evaluated as being compatible if the PCD is able to recognize all cards.
4	Transmission protocol	Send command from the PCD to the card, and verify the response from the card based on "13. Transmission Protocol".	Evaluated as being compatible if the response from the card complies with the specifications.

(2) Test Combinations

Test combinations are shown in "Fig. 17-1 Block Diagram". Which combination of tests to be performed is selected according to the functions of the equipment being tested.

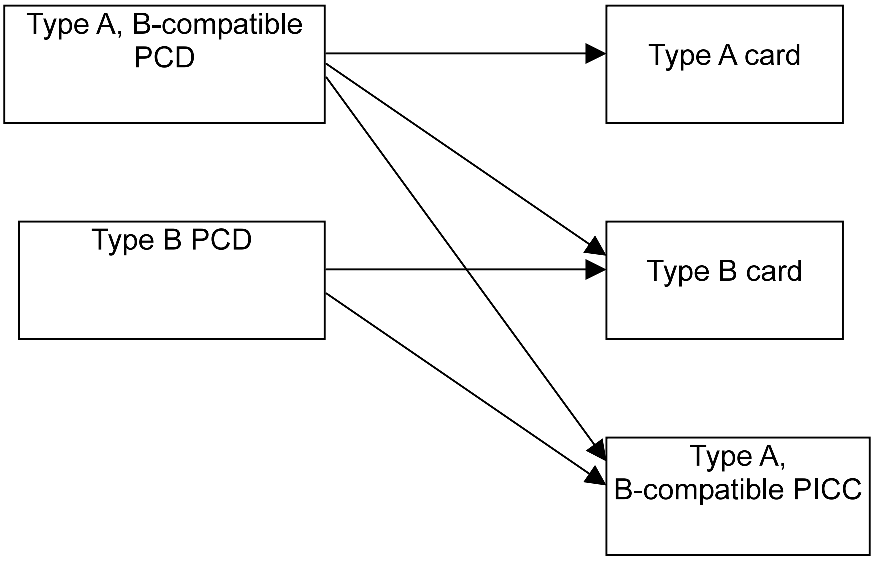


Fig. 17-1 Block Diagram

[Reference] Example of Compatibility Verification Sheet

Card

Note: For the purpose of distinction, the reference PICC of the basic specifications is designated as reference PICC-M, while the calibration coil is designated as calibration coil-M.

Item		Measuring conditions		Specifications	Classification			Card type		Measurement results	Evaluation	Remarks
					Basic	Extended	Reference	For single card operation	For two card operation			
14.3.1.2	Minimum Operating Magnetic Field Test	Single card		1.5 A/m or less	√							
				(4) A/m or less		√						
		Superimposed cards	Two cards	(4) A/m or less		√		(not applicable)				
			Ref. PICC-M	(4) A/m or less		√		(not applicable)				
			Ref. PICC- S	(4) A/m or less		√		(not applicable)				
			Ref. PICC- L	(4) A/m or less		√		(not applicable)				
14.3.1.3	Maximum Operating Magnetic Field Test	Single card		7.5 A/m or more	√							
		Superimposed cards	Two cards	7.5 A/m or more		√		(not applicable)				
			Ref. PICC-M	7.5 A/m or more		√		(not applicable)				
			Ref. PICC- S	7.5 A/m or more		√		(not applicable)				
			Ref. PICC- L	7.5 A/m or more		√		(not applicable)				
14.3.1.4	Maximum Applied Magnetic Field Test	Single card		Card must function normally after applying magnetic field		√						
		Superimposed cards	Two cards	Card must function normally after applying magnetic field		√		(not applicable)				
			Ref. PICC-M	Card must function normally after applying magnetic field		√		(not applicable)				
			Ref. PICC- S	Card must function normally after applying magnetic field		√		(not applicable)				
			Ref. PICC- L	Card must function normally after applying magnetic field		√		(not applicable)				
14.3.1.5	Signal Receive Test	Single card		Must be able to receive		√						
14.3.1.6	Load Modulation Test	Single card		Modulation level: 30/H ˆ 1.2 mVp or more	√							
		Superimposed cards	Two cards	Modulation level: 30/H ˆ 1.2 mVp or more		√		(not applicable)				
			Ref. PICC-M	Modulation level: 30/H ˆ 1.2 mVp or more		√		(not applicable)				
			Ref. PICC- S	Modulation level: 30/H ˆ 1.2 mVp or more		√		(not applicable)				
			Ref. PICC- L	Modulation level: 30/H ˆ 1.2 mVp or more		√		(not applicable)				
14.3.1.7	Reference PICC Superimposition Test	Superimposed cards	Ref. PICC-M	Receive voltage of (6.8) V or more at load of 910 Ohm		√		(not applicable)				
			Ref. PICC- S	Receive voltage of (6.8) V or more at load of 910 Ohm		√		(not applicable)				
			Ref. PICC- L	Receive voltage of (6.8) V or more at load of 910 Ohm		√		(not applicable)				
14.3.2	Testing Using Test PCD-S	Single card		Must receive response from card			√					
		Superimposed cards	Two cards	Must receive response from card			√					
			Ref. PICC-M	Must receive response from card			√					
			Ref. PICC- S	Must receive response from card			√					
			Ref. PICC- L	Must receive response from card			√					

PCD

Item			Measuring conditions		Specifications	Classification			RW type		Measurement results	Evalu-ation	Re-marks
						Basic	Extend-ed	Refer-ence	Slot insertion	Open			
15.3.1	Magnetic Field Strength	Maximum Generated Magnetic Field	Reference PICC used	Ref. PICC-M	3V or less	√							
				Ref. PICC- S	Same as above		√						
				Ref. PICC- L	Same as above		√						
		Minimum Generated Magnetic Field	↑	Ref. PICC-M	3V (1.5A/m) or more	√							
					3V (4A/m) or more		√						
				Ref. PICC- S	Same as above		√						
				Ref. PICC- L	Same as above		√						
		Maximum Generated Magnetic Field	Calibration coil used	Calibration coil-M	7.5A/m or less		√						
		Minimum Generated Magnetic Field	Calibration coil used	Calibration coil-M	(4)A/m or more		√						
15.3.2	Power Transfer Test		One reference PICC (resonance frequency: 19 MHz)	Ref. PICC–M	3 V or more at load of 8 kOhm	√							
				Ref. PICC-M	(6.8) V or more at load of 910Ohm			√					
				Ref. PICC- S	(6.8) V or more at load of 910Ohm			√					
				Ref. PICC- L	(6.8) V or more at load of 910Ohm			√					
			Two reference PICCs	M–M	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				M-S	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				M-L	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				S-M	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				S-S	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				S-L	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				L-M	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				L-S	(6.8) V or more at load of 910Ohm			√		(not applicable)			
				L-L	(6.8) V or more at load of 910Ohm			√		(not applicable)			
15.3.3	Modulation Waveform		Calibration coil used	Calibration coil-M	Specifications must be satisfied	√							
			One reference PICC	Ref. PICC-M	Same as above		√						
				Ref. PICC- S	Same as above		√						
				Ref. PICC- L	Same as above		√						
			Two reference PICCs	M-M	Same as above		√			(not applicable)			
				M-S	Same as above		√			(not applicable)			
				M-L	Same as above		√			(not applicable)			
				S-M	Same as above		√			(not applicable)			
				S-S	Same as above		√			(not applicable)			
				S-L	Same as above		√			(not applicable)			
				L-M	Same as above		√			(not applicable)			
				L-S	Same as above		√			(not applicable)			
				L-L	Same as above		√			(not applicable)			
15.3.4	Reception Ability of Load Modulation Signal			Ref. PICC-M	Must be able to receive	√							
				Ref. PICC- S	Same as above		√						
				Ref. PICC- L	Same as above		√						