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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Mechanical structures for electrical and electronic equipment – Thermal management for cabinets in accordance with IEC 60297 and IEC 60917 series – Part 6: Air recirculation and bypass of indoor cabinets

Structures mécaniques pour équipements électriques et électroniques – Gestion thermique pour les armoires conformes aux séries IEC 60297 et IEC 60917 – Partie 6: Recyclage et dérivation de l’air des armoires intérieures

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MECHANICAL STRUCTURES FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – THERMAL MANAGEMENT FOR CABINETS IN ACCORDANCE WITH IEC 60297 AND IEC 60917 SERIES –

Part 6: Air recirculation and bypass of indoor cabinets

FOREWORD

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International Standard IEC 62610-6 has been prepared by subcommittee 48D: Mechanical structures for electrical and electronic equipment, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

The text of this International Standard is based on the following documents:

CDV	Report on voting
48D/700/CDV	48D/715/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62610 series, published under the general title *Mechanical structures for electrical and electronic equipment – Thermal management for cabinets in accordance with iec 60297 and iec 60917 series*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The signal speed and component density of electrical and electronic equipment in the ICT field and the FA field, such as high performance servers, communications equipment, and electronic control equipment have been steadily increasing. As a result, the heat generation density of the integrated circuits, the power consumption of the equipment, and therefore the cooling task has also been increasing. In a computer room common in the ICT field, where many cabinets for mounting subrack and/or chassis-based equipment are installed and high availability is required, it is necessary to pay attention so that the equipment does not experience high temperature problems.

To prevent high temperature problems with the electronic equipment, it is important that the air conditioning installed in a computer room effectively contributes to the cooling of the cabinet for mounting subrack and/or chassis-based equipment. Indicators relating to airflow such as recirculation and bypass**,** are used to judge the effectiveness of the air conditioning system. Recirculation is the ratio at which the cabinets in the computer room suck in their own exhaust air, which affects the thermal problems of the equipment as it raises the intake air temperature. Bypass is the ratio at which the cooled supply air does not pass through the cabinets in the computer room, and affects the energy efficiency as it increases the air conditioning energy. If these ratios, especially the recirculation ratio, are kept low, the airflow of the computer room can be regarded as effectively cooling the cabinets. Conversely, if air recirculation or bypass occurs, the temperature of subracks and/or chassis-based equipment in the cabinet rises. Therefore it is necessary to provide similar indices to measure the effectiveness of the cooling airflow for the equipment in the cabinet.

The existing standard for forced air cooling, IEC 62610-2, introduces a method for determining the ideal airflow for a forced air cooled cabinet assembled with associated subrack and/or chassis-based equipment. The standard also defines qualitative guidelines for avoiding recirculation in such cabinets and a server(computer) room. However, concrete numerical values and the evaluation method of the recirculation have not been defined. It was impossible to judge in advance whether the cabinet for mounting subrack and/or chassis-based equipment satisfies the environmental conditions, or whether the empty cabinet has sufficient cooling when subrack and/or chassis-based equipment are mounted.

This document defines a method for easily measuring the recirculation ratio (RC) and the bypass ratio (BP) of the airflow in a cabinet and provides performance levels of recirculation on effectiveness of the cooling airflow in such cabinets. This can be regarded as the degree of conformity with respect to behaviour of the airflow in the cabinet in the computer room. Alternatively, even for an outdoor cabinet including a heat exchanger and an air conditioner, this method can be effectively utilized as an index for knowing the degree of airflow appropriately contributing to cooling the internal space in which the equipment is mounted.

The purpose of this document is to provide:

- for the equipment integrator and development designer of the cabinet the criteria for efficiently and correctly determining the specification, and
- for the supplier of the cabinet the measuring and classifying method for the airflow recirculation rate of the subrack and/or chassis-based equipment installed in the cabinet.

This document is addressed to the mechanical structures in accordance with IEC 60297 and IEC 60917 series.

MECHANICAL STRUCTURES FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – THERMAL MANAGEMENT FOR CABINETS IN ACCORDANCE WITH IEC 60297 AND IEC 60917 SERIES –

Part 6: Air recirculation and bypass of indoor cabinets

1 Scope

This part of IEC 62610 which deals with thermal management for cabinets in accordance with IEC 60297 and IEC 60917 series, provides compatible measurement methods of recirculation ratio and bypass ratio which are indicators for defining quality of airflow in the forced air cooling that can be commonly applied to indoor cabinets for mounting subrack and/or chassis-based equipment.

NOTE 1 Both recirculation and bypass represent leakage airflows, i.e. detrimental phenomena in terms of cooling efficiency; their measurement is obviously aimed at their mitigation.

This document contains the following:

a) the definition of recirculation and bypass flow rates in the cooling of the cabinet,
b) the levels of the recirculation ratio RC,
c) the definition of the formula for the recirculation ratio RC_s of forced air cooling subrack and/or chassis-based equipment installed in the cabinet,
d) the definition formula of recirculation ratio RC_r and bypass rate BP_r of the entire cabinet,
e) the requirements of the measuring method of each temperature necessary for calculating the recirculation ratio RC_s, RC_r and bypass ratio BP_r.

NOTE 2 This document includes the definition of measuring bypass ratio, but excludes the definition of levels of bypass ratio.

The drawings used are not intended to indicate product design. They are only for explanatory indications for defining forced air cooling airflows.

The recirculation and bypass measurement methods dealt with in this document are assumed to be applied to a cabinet installed indoors. The cooling air inlet is at the front or the bottom of the cabinet and the heated air is exhausted to the rear or the top. These methods are also applicable to a cabinet that is installed outdoors and has a cooling device such as a heat exchanger or an air conditioner on the front or the back (see Annex C).

The recirculation ratio of a subrack or a cabinet is defined for each individual subrack or chassis-based equipment mounted in the cabinet or for the entire cabinet. The bypass ratio of a cabinet is defined for the entire cabinet.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60297-3-100, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-100: Basic dimensions of front panels, subracks, chassis, racks and cabinets*

IEC 60917-1, *Modular order for the development of mechanical structures for electrical and electronic equipment practices – Part 1: Generic standard*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
recirculation flow rate
f_{RC}
flow rate of the air that returns directly from the exhaust of the equipment to be cooled to the intake side of the equipment

3.2
bypass flow rate
f_{BP}
flow rate of the air going through a cabinet without going through any of the equipment to be cooled

3.3
recirculation ratio of a subrack
RC_s
ratio of the recirculation flow rate of a subrack or a chassis-based equipment to the flow rate of the equipment

3.4
recirculation ratio of a cabinet
RC_r
ratio of the total recirculation flow rate of all of the subracks mounted in a cabinet to the total flow rate of all of the subracks mounted in a cabinet

3.5
bypass ratio of a cabinet
BP_r
ratio of the bypass flow rate of a cabinet to the airflow rate of a cabinet

3.6
dummy thermal load
DTL
simulator that reproduces thermal fluid behaviour such as heat dissipation and flow rate generated by subrack and/or chassis-based equipment

Note 1 to entry: Generally, a heater and a fan mounted in a chassis are used, and the amount of heat dissipation and the fan flow rate can be adjusted.

4 Recirculation level

The recirculation level RL indicates the degree of recirculation of a subrack or a chassis or a cabinet and is represented by levels RL1 through RL4 according to the recirculation ratio of a subrack RC_s or recirculation ratio of a cabinet RC_r. See Table 1.

Table 1 – Recirculation level

Recirculation level	Recirculation ratio of a subrack RC_S or of a cabinet RC_r %
RL1	more than 33
RL2	20 to 33
RL3	10 to 20
RL4	0 to 10

If the RC_s or RC_r value varies depending on the mounting condition or position of the subrack and/or chassis, or the conditions of cables and/or other mechanical parts, etc., the manufacturer shall clearly indicate the configuration and the corresponding recirculation level in the data sheet.

5 Determination of recirculation and bypass ratio

5.1 Cooling airflow in a cabinet

Figure 1 schematically shows the airflow in the cabinet in which the subrack is mounted, with arrows by size and direction according to the flow balance. In the equipment cabinet, cooling air is supplied from the front, enters from the inlet of the subrack into the interior, cools the interior of the subrack, exhausts from the subrack, and is exhausted from the rear of the cabinet. A part of the cabinet intake bypasses the subrack and is directly exhausted to the outside of the cabinet without passing through the subrack. A part of the subrack exhaust air is recirculated, returning to the subrack intake and not exhausting outside the cabinet.

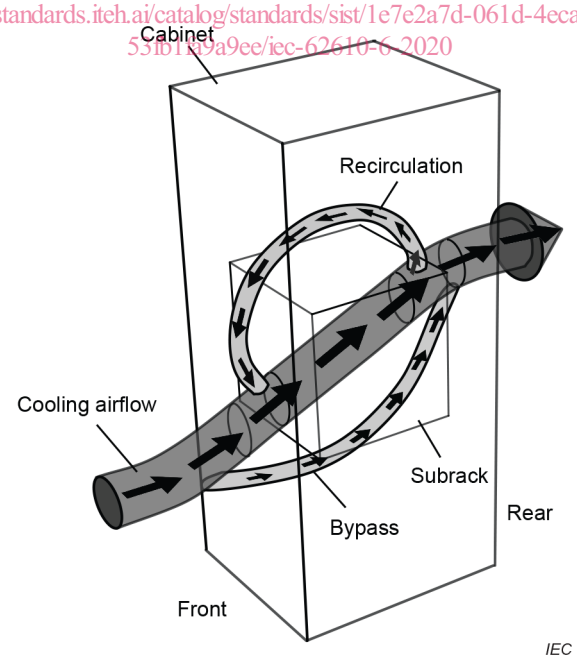


Figure 1 – Airflow in a cabinet

Figure 2 is a diagram showing the airflow balance of the equipment cabinet. Figure 2a) shows an airflow diagram in which all subracks mounted in the cabinet are regarded as a subrack group. The airflow of each subrack in the subrack group is shown by a diagram of Figure 2b).

Symbols of flow rate and temperature are defined as follows.

F_R airflow rate of a cabinet

F_S airflow rate of a group of subracks

F_{S-n} airflow rate of n-th subrack

f_{RC} recirculation flow rate of a cabinet

f_{BP} bypass flow rate of a cabinet

f_{RC-n} recirculation flow rate of n-th subrack

T_{Ri} intake air temperature of a cabinet

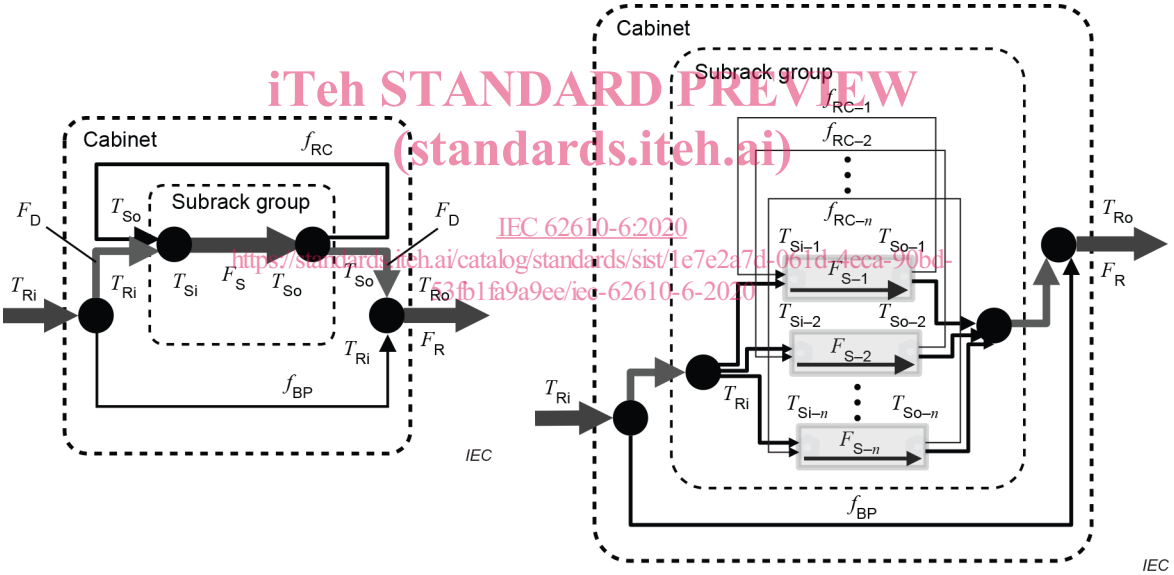
T_{Si} intake air temperature of a group of subracks

T_{Si-n} intake air temperature of n-th subrack

T_{Ro} exhaust air temperature of a cabinet

T_{So} exhaust air temperature of a group of subracks

T_{So-n} exhaust air temperature of n-th subrack.



a) Diagram of all subracks as a subrack group

b) Diagram of each subrack

Figure 2 – Diagram of cabinet airflows

5.2 Recirculation ratio of a subrack

The recirculation ratio of a subrack RC_s represents the ratio of the flow rate of exhaust of the n-th subrack recirculated to the intake of n-th subrack $f_{RC\text{-}n}$ to the flow rate of the n-th subrack $F_{S\text{-}n}$ in the cabinet.

When n subracks and/or chassis-based equipment are mounted in a cabinet, recirculation ratio of a subrack RC_s for each subrack and/or chassis is defined by the following formula.

$$RC_s = \frac{f_{RC-n}}{F_{S-n}}$$

where

f_{RC-n} is the recirculation flow rate of n-th subrack;

F_{S-n} is the airflow rate of n-th subrack.

5.3 Recirculation ratio of a cabinet

The recirculation ratio of a cabinet RC_r is the recirculation rate for all the subrack and/or chassis-based equipment mounted in the cabinet, that is, for the subrack group, and is defined as follows.

$$RC_r = \frac{f_{RC}}{F_S} = \frac{\sum_n f_{RC-n}}{\sum_n F_{S-n}}$$

where

F_S is the airflow rate of a group of subracks;

f_{RC} is the recirculation flow rate of a cabinet;

F_{S-n} is the airflow rate of n-th subrack;

f_{RC-n} is the recirculation flow rate of n-th subrack.

5.4 Bypass ratio of a cabinet

The bypass ratio of a cabinet BP_r is defined as the ratio of the flow rate directly exhausted without passing through the subrack group to the cabinet flow rate, and is represented as following formula.

$$BP_r = \frac{f_{BP}}{F_R}$$

where

F_R is the airflow rate of a cabinet;

f_{BP} is the bypass flow rate of a cabinet.

6 Measurement of recirculation and bypass

6.1 Measurement of recirculation of a subrack

The recirculation ratio of a subrack RC_S is the ratio of the flow rate, but by measuring the temperatures at some points of the cabinet, it should be calculated as the ratio of those temperatures as specified in Annex B. The definition formula of the measurement value of the recirculation ratio of a subrack is shown.

$$RC_s = \frac{T_{Si-n} - T_{Ri}}{T_{So-n} - T_{Ri}}$$

where

T_{Si-n} is the intake air temperature of n-th subrack;

T_{So-n} is the exhaust air temperature of n-th subrack;

T_{Ri} is the intake air temperature of a cabinet.

6.2 Measurement of recirculation of a cabinet

The recirculation ratio of a cabinet RC_r is the ratio of the flow rate, but by measuring the temperatures at some points of the cabinet, it should be calculated as the ratio of those temperatures as specified in Annex B. The definition formula of the measurement value of the recirculation ratio of a cabinet is shown.

$$RC_r = \frac{T_{Si} - T_{Ri}}{T_{So} - T_{Ri}}$$

where

T_{Si} is the intake air temperature of a group of subracks;

T_{So} is the exhaust air temperature of a group of subracks;

T_{Ri} is the intake air temperature of a cabinet.

6.3 Measurement of bypass of a cabinet

The bypass ratio of a cabinet BP_r is the ratio of the flow rate, but by measuring the temperatures at some points of the cabinet, it should be calculated as the ratio of those temperatures as specified in Annex B. The definition formula of the measurement value of the bypass ratio of a cabinet is shown.

$$BP_r = \frac{T_{So} - T_{Ro}}{T_{So} - T_{Ri}}$$

where

T_{So} is the exhaust air temperature of a group of subracks;

T_{Ri} is the intake air temperature of a cabinet;

T_{Ro} is the exhaust air temperature of a cabinet.

6.4 Measurement methods of temperature

6.4.1 Intake air temperature of a subrack

The measurement value of the intake air temperature of a subrack T_{Si} is measured at three points 30 mm away from the intake face of the subrack and/or chassis-based equipment, and the average value of them is taken as the measurement value.

In the case where the intake fans are mounted at the position of the intake port, the measurement value is set as the average value of the fan intake air temperatures.

6.4.2 Intake air temperature of a subrack group

When obtaining the intake air temperature of the subrack group consisting of all subracks and/or chassis-based equipment mounted on the cabinet, the following weighted average value is used.

$$\overline{T_{Si}} = \frac{\sum_{n}\left(F_{S-n} \cdot T_{Si-n}\right)}{\sum_{n} F_{S-n}}$$

However, if it is difficult to know the individual subrack flow rates and it can be determined that the individual subrack flow rates are about the same, the arithmetic mean value may also be used.

6.4.3 Exhaust air temperature of a subrack

The measurement value of the exhaust air temperature of a subrack T_{So} is measured at three points 10 mm away from the exhaust face of the subrack and/or chassis-based equipment, and the average value of them is taken as the measurement value.

Where the exhaust fans are mounted at the exhaust position, the measurement value is set as the average value of the fan exhaust air temperatures.

6.4.4 Exhaust air temperature of a subrack group

When obtaining the exhaust air temperature of the subrack group consisting of all subracks and/or chassis-based equipment mounted on the cabinet, the following weighted average value is used.

$$\overline{T_{So}} = \frac{\sum_{n}\left(F_{S-n} \cdot T_{So-n}\right)}{\sum_{n} F_{S-n}}$$

However, if it is difficult to know the individual subrack flow rates and it can be determined that the individual subrack flow rates are about the same, the arithmetic mean value can also be used.

6.4.5 Intake air temperature of a cabinet

The intake air temperature of a cabinet T_{Ri} is measured at three points in the upper, middle, and lower parts of the intake face of the cabinet, the distance from the face is 50 mm to 200 mm away, and the average value of the three points is taken as the measurement value. If the cabinet is configured as a cold aisle containment, the temperature at a position representing the cold aisle may be used. And, if the cabinet is installed in an indoor open space, the temperature at a position representing the room temperature may be used.

6.4.6 Exhaust air temperature of a cabinet

The exhaust air temperature of a cabinet T_{Ro} is measured at three points in the upper, middle, and lower parts of the exhaust face of the cabinet, the distance from the face is 10 mm to 30 mm away, and the average value of the three points is taken as the measurement value. If the cabinet is configured as a hot aisle containment, the temperature at a position representing the hot aisle may be used.