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Environmental Engineering (EE);
Interworking between Direct Current/Isolated (DC/I) and Direct Current/Common (DC/C) electrical power systems

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

ETSI EN 300 253 [i.1] recognizes the Direct Current/Common (DC/C) and Direct Current /Isolated (DC/I) electrical power systems usable in telecommunication equipments.

The aim of the present document is to show the effective interconnecting possibility of the two systems and to list some engineering precautions ensuring good interworking.

1 Scope

The present document describes and establishes simplified models of the different sections of the ground distribution network constituting the DC/I and the DC/C electrical power systems.

These models are interworked to identify the common impedance where DC power supply currents can circulate (interconnection between DC/C and DC/I, DC/C and DC/C, DC/I and DC/I).

These results allow the establishment of some basic engineering advice that should be applied to guarantee the good behaviour when interconnecting two systems. These precautions are given for functionality reasons:

- the noise immunity of the pre-existing system and of the links between the system and the MDF should be conserved;

and safety aspects:

- the screens of signal cables between the pre-existing system and the Main Distribution Frame (MDF), the conductors and the connections of the pre-existing system have to withstand additional currents.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 300 253 "Environmental Engineering (EE); Earthing and bonding of ICT equipment powered by -48 VDC in telecom and data centres".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

DC power return conductor: name given to the 0V power supply conductor

NOTE: It is also called "battery return".

DC/C system: system where the DC power return conductors are connected to the Common Bonding Network (CBN), ensuring simultaneously the supply and protection functions

NOTE: The DC/C system is also called a "2 wire system".

DC/I system: system where the current return function and the grounding of the equipment are separated

NOTE: The DC/I system is also called a "3 wire system".

3.2 Symbols

For the purposes of the present document, the following symbols apply:

AC	Alternating Current
B1	Power source and the entry point of the system
B2	The entry-point of the system room and the system
C1	DC return conductors and CBN at MET
C2	DC return conductors and CBN at power source level
C3	DC return conductors and CBN at the SRPP of the system
C4	DC return conductors and CBN in the system (SYST)
D1	AC Mains Protective Conductor to the Power Plant
G1	Power Plant to Main Earthing Terminal
G2	Main Distribution Frame to the Main Earthing Terminal
G3	Room Grounding Terminal to Main Earthing Terminal
G4	Room Ground Terminal to SRPP
G5	System to SRPP
G6	Between 2 points of the system
RB1	equivalent impedance is called RB 1
RB2	Equivalent impedance is called RB 2
RC1	Equivalent impedance is called RC 1
RC2	Equivalent impedance is called RC 2
RC3	Equivalent impedance is called RC 3
RC4	Equivalent impedance is called RC 4
RD 1	The equivalent impedance is called RD 1
RE	For simplification reasons, the impedances RC 1, RC 2 and RG 1 (PWP grounds) have been replaced by the equivalent impedance RE 1
RG1	Equivalent impedance is called RG 1
RG2	Equivalent impedance is called RG 2
RG3	Equivalent impedance is called RG 3
RG4	Equivalent impedance is called RG 4
RG5	Equivalent impedance is called RG 5
RG6	Equivalent impedance is called RG 6
RS	equivalent impedance is called RS
S	Between the System and

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CBN	Common Bonding Network
DC/C	Direct Current/Common
DC/I	Direct Current/Isolated
MDF	Main Distribution Frame
MET	Mains Earthing Terminal
PWP	PoWer Plant.
RGT	Room Grounding Terminal.
SRPP	System Reference Potential Plane
SYST	System

4 Description of the DC/C and DC/I systems

4.1 Global view of the systems

In this study, the DC power supply current is supplied by a power plant whose positive polarity (0 V) is connected to the CBN. This is generally the case for telecom buildings.

The two systems (DC/C and DC/I) are made up of the following elements:

1) the PoWer Plant (PWP) installed outside the system;
2) the Grounding network System Reference Potential Plane (SRPP) integrating the system and which constitutes its reference plane;
3) the Telecom system (SYST) itself constituted by its items**:** racks, subracks, boxes, etc.;
4) the Main Distribution Frame (MDF) of the subscriber line and transmission circuit connection.

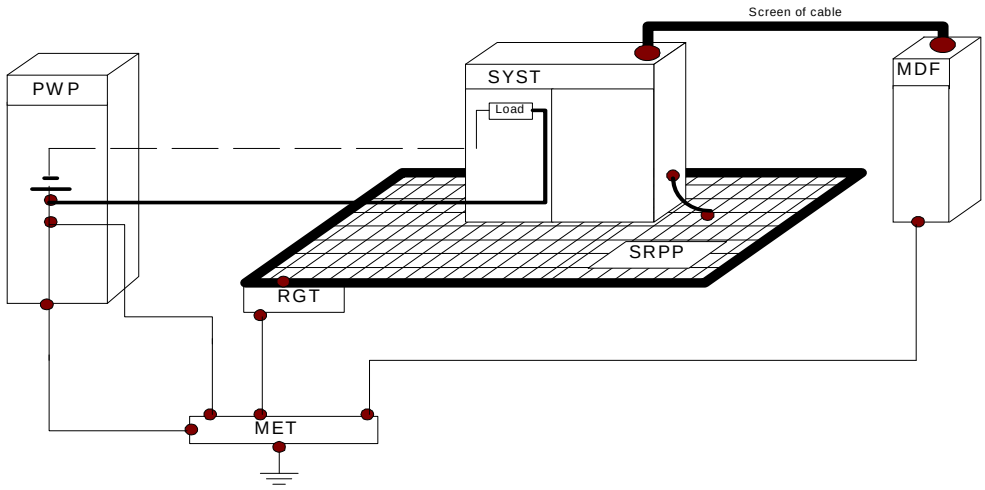


Figure 1: Entities constituting a DC/I system

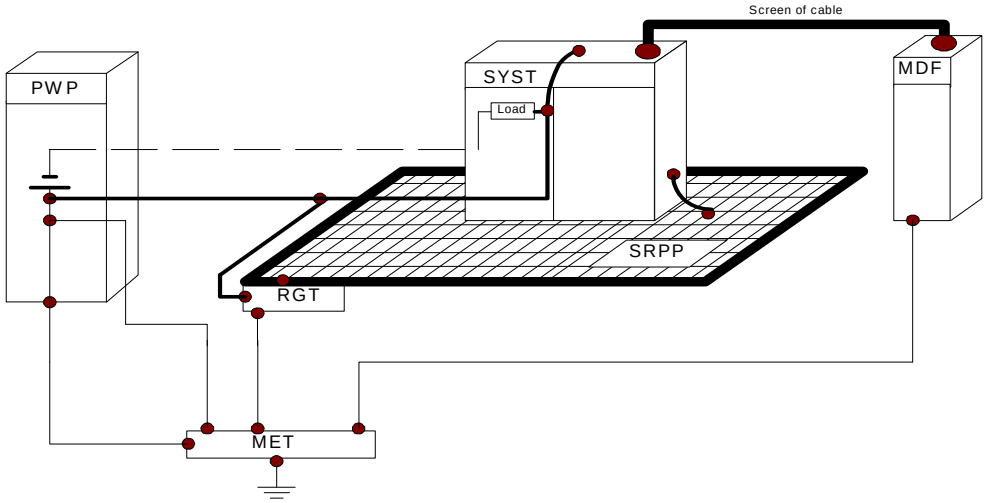


Figure 2: Entities constituting a DC/C system

4.2 Identification of the connections

The paths which form the CBN are identified in figure 3. They have been divided in 4 groups:

1) **The ground connections:[G]:** ensure the equipotentiality and the earthing of the equipment for safety and functional reason.

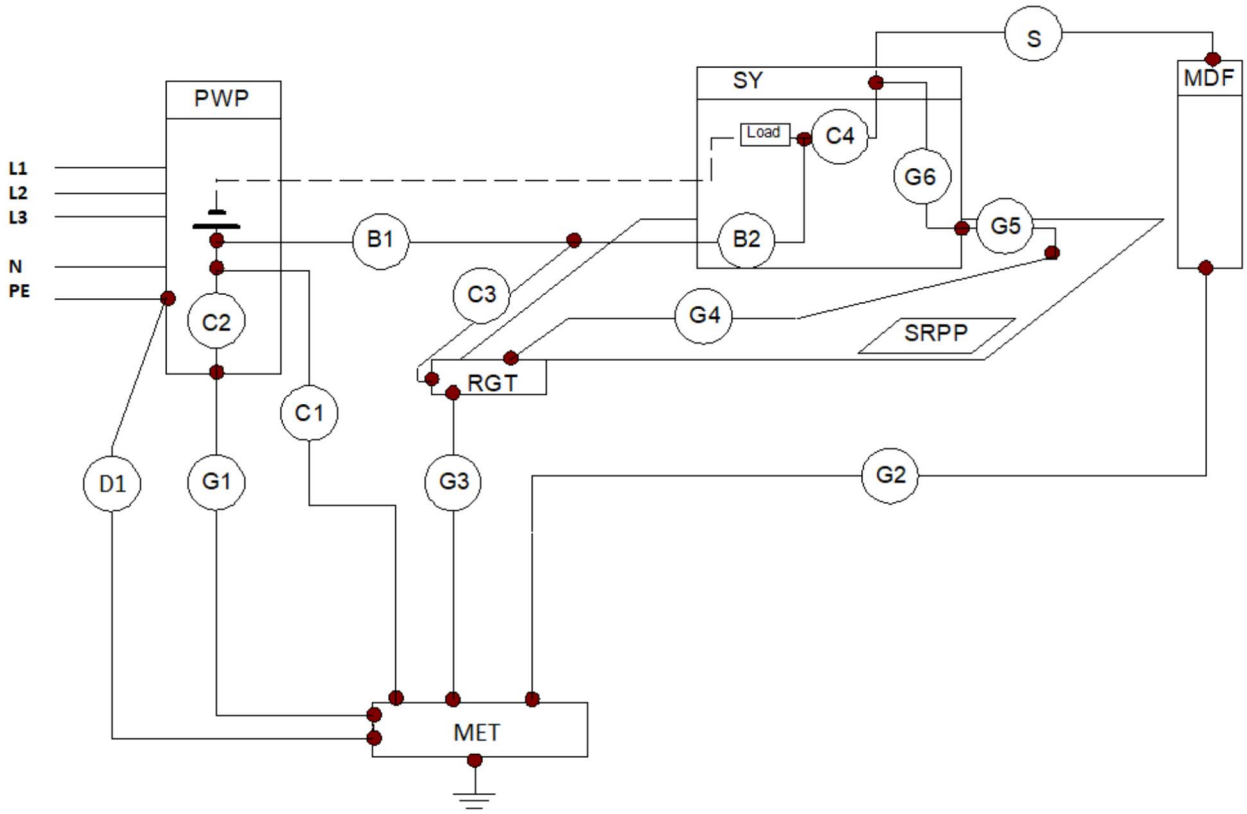
2) **The DC power conductors:[B]:** are represented by the DC power return conductors.

3) **The connection point of DC Power return conductor to the CBN:[C]:** (according to clause 6.1 of ETSI EN 300 253 [i.1]).

NOTE: Not all connections shown in the figures may be present.

4) **The signal conductors:[S]:** are cables and screens between the system and MDF.

5) **A.C mains protective conductor:** Refer to Annex C of ETSI EN 300 253 [i.1].



NOTE: In the installation, other possible paths exist, created by cable trays, building steel etc., but are not taken into account because their impedances are neither perfectly controlled nor guaranteed over time. It would be difficult or even uncertain to assess their contribution to the circulation of current.

Figure 3: Power supply and ground connections in a system

4.3 Definition of the connections

4.3.1 Ground connections (G connections)

G1: Power Plant to Main Earthing Terminal: (The equivalent impedance is called RG 1)

- Represents the link from the power source and the MET. It is constituted:
  - either directly by a single conductor; or
  - by means of a ring conductor set up in the PWP room.

G2: Main Distribution Frame to the Main Earthing Terminal: (The equivalent impedance is called RG 2)

- Represents the link between the metallic frame constituting the MDF and the MET. It is composed of:
  - either directly by only one conductor; or
  - by means of a ring conductor set up at the MDF room.

G3: Room Grounding Terminal to Main Earthing Terminal: (The equivalent impedance is called RG 3)

- Link between the ground interface Room Grounding Terminal (RGT) of the system room and the MET. It is made up of:
  - either directly by a single conductor; or
  - by the intermediary of the CBN and reinforcement conductors.

NOTE 1: For small installations, RGT and MET can be merged. In this case: RG 3= 0.

G4: Room Ground Terminal to SRPP: (The equivalent impedance is called RG 4)

- Represents the proper impedance of the bonding network on which the system is installed. This impedance includes the system room ring conductor.

G5: System to SRPP: (The equivalent impedance is called RG 5)

- Represents the connection of an element or group of elements of a system to the room bonding network.

G6: Between 2 points of the system: (The equivalent impedance is called RG 6)

- Represents the ground impedance of the system. This is the impedance between the connecting point of the DC return conductor to the frame and the connecting point of the frame to the SRPP.

NOTE 2: The value of this impedance depends both on the density of the bonding of the metallic parts and on the internal reference planes of the systems.

4.3.2 DC Power supply return links (B connection)

B1: Power source and the entry point of the system: (The equivalent impedance is called RB 1)

- Is the DC power return section placed between the power source and the entry point of the system.

B2: The entry-point of the system room and the system: (The equivalent impedance is called RB 2)

- Is the DC power return section placed between the power source and the entry point of the system.

NOTE 1: For DC/C distribution, the voltage drop along each DC power return conductor should be less than 1 V at maximum load current. One concern of this requirement is to avoid electrochemical corrosion in metallic structures by stray currents (see clause 6.1 of ETSI EN 300 253 [i.1]).

NOTE 2: For DC/I distribution, the voltage drop in DC power return conductors is calculated to ensure that at the maximum load current the supply voltage at the power interface to the equipment is within its specified limits.

4.3.3 DC return conductor connections (C connections)

C1: DC return conductors and CBN at MET: (The equivalent impedance is called RC 1)

- Represents the link between the DC return conductor and the MET.

C2: DC return conductors and CBN at power source level: (The equivalent impedance is called RC 2)

- Represents the link between the DC return conductor and the frame of the power source.

C3: DC return conductors and CBN at the SRPP of the system: (The equivalent impedance is called RC 3)

- Represents the link between the DC return conductor and the RGT at the entry point of the system.

C4: DC return conductors and CBN in the system (SYST): (The equivalent impedance is called RC 4)

- Represents the link between the DC return conductor and the frame of the system.

NOTE: For DC/I distribution , the connections C1, C3 and C4 do not exist. The impedances RC1, RC3 and RC4 are considered to be infinite.

4.3.4 Signal screen connections (S connections)

S: Between the System and MDF: (The equivalent impedance is called RS)

- Represents the screens of signal cables which are at least bonded at each end to the metallic structure of the system and the MDF (according to clause 5.5 of ETSI EN 300 253 [i.1]).

4.3.5 AC Mains Protective Conductor (D1 connection)

D1: AC Mains Protective Conductor to the Power Plant: (The equivalent impedance is called RD 1)

- Represents the link from the power source and the MET. It is constituted:

  - by a single conductor.

5 Modelling of the systems

5.1 DC/C power supply model

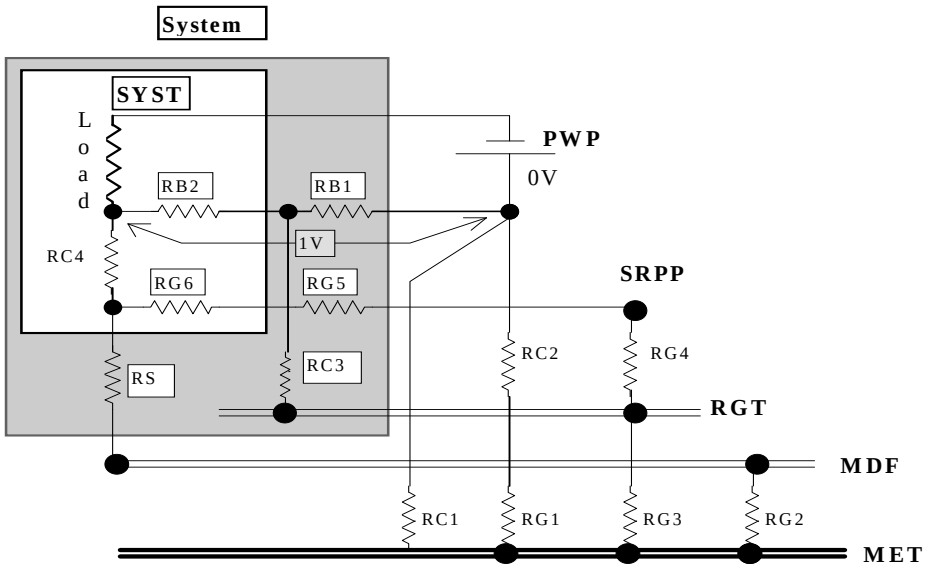


Figure 4: Electrical diagram for DC/C power supply principle

5.2 DC/I power supply model

The main characteristic of this distribution is the fact that the DC power supply current is confined to a single loop.

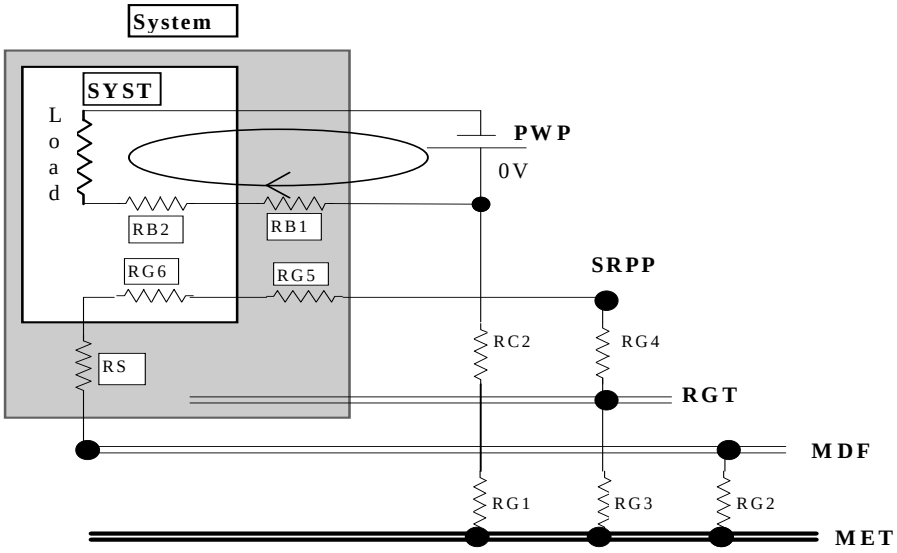


Figure 5: Electrical diagram for DC/I power supply principle

6 Interworking

6.1 Interworking between 2 systems

6.1.0 Introduction

In all the following clauses, a new system (System B) is considered to be connected to a pre-existing one (System A). They are installed in the same CBN and exchanging signals through a common MDF. For each configuration, the currents circulating through the CBN are analysed. Engineering precautions resulting from this analysis are listed for each configuration.

NOTE: For simplification reasons, the impedances RC 1, RC 2 and RG 1 (PWP grounds) have been replaced by the equivalent impedance RE 1.

6.1.1 Interconnection between DC/C and DC/I models

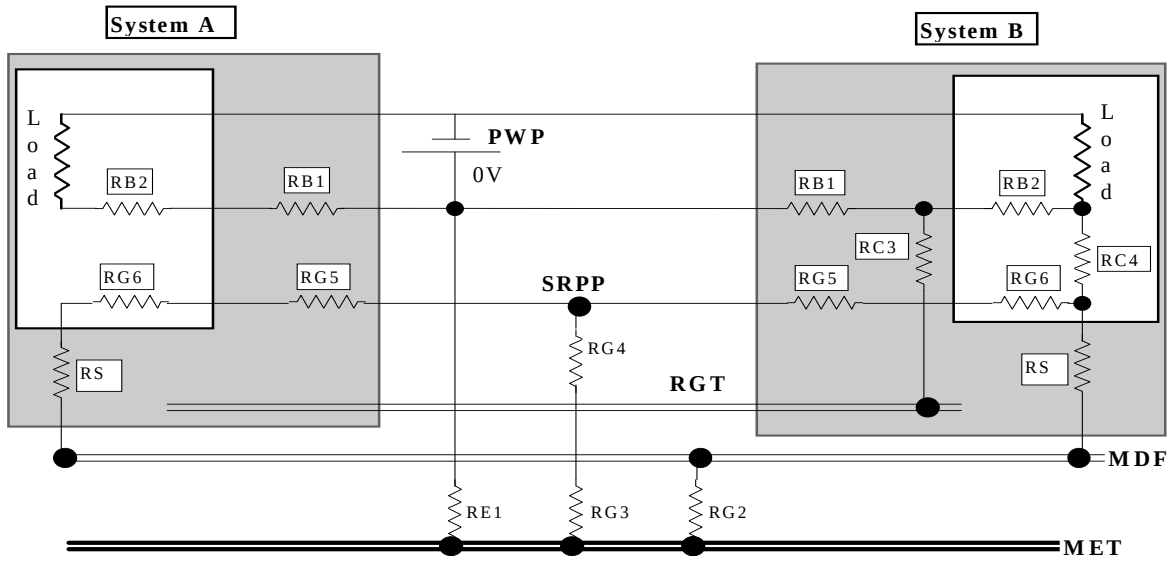


Figure 6: DC/I and DC/C interconnection

This diagram shows that a part of the current consumed by System B(DC/C system) can pass through the common impedance of the two systems RG 2, RG 3 and RE 1 and through the impedances RG 5, RG 6 and RS of system A (DC/I system).

Engineering precautions:

It is recommended to verify the following points before interconnection:

- the grounding conductors and connections of system A should be dimensioned to withstand the additional currents due to the introduction of the system B;
- the voltages generated by additional current inside the bounding network of system A (RG6) do not reduce its noise immunity (reduction of the immunity of the asymmetrical links which are referenced to the ground of system A);
- the signal cables between system A and MDF will neither suffer from excessive current heating, nor be subject to voltage drop (additional current through RS) which could create transmission faults in the case of asymmetrical links (for example: coaxial cables).

NOTE: All these precautions will also have to be applied to the DC/I system in case of connection with a pre-existing DC/C one.

6.1.2 Interconnection between 2 DC/C models

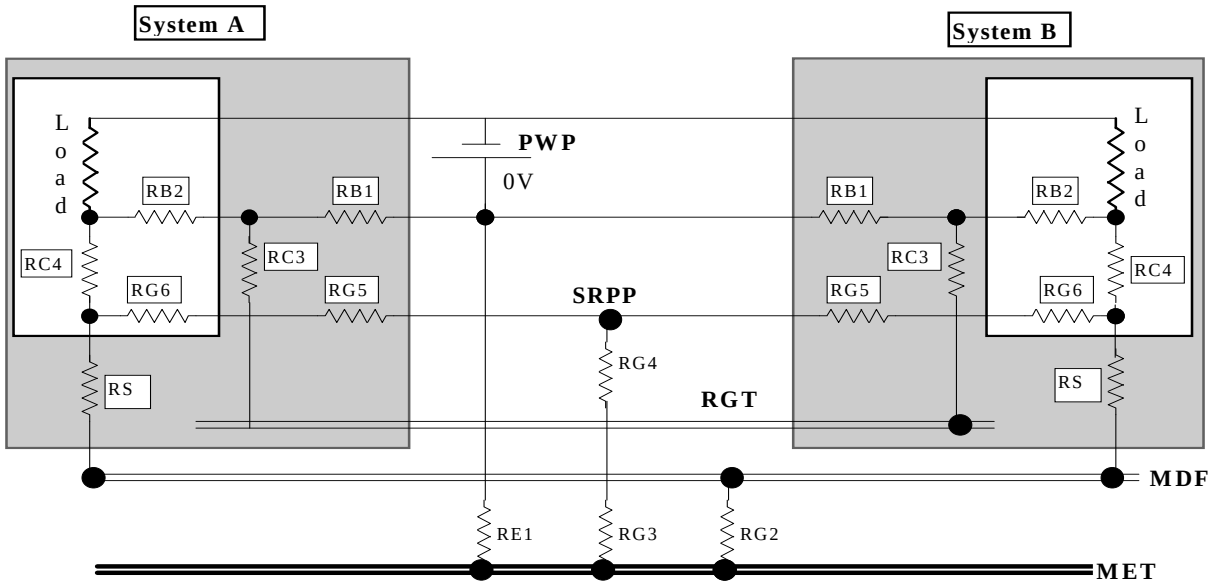


Figure 7: 2 DC/C interconnection

In this configuration, the total DC power supply current is split up into all ground connections of the 2 DC/C systems, and will modify the initial share of DC return current of system A.

Engineering precautions:

It is recommended to verify the following points before interconnection:

- the conductors and the connections of the 2 systems (A and B) have been dimensioned to withstand the additional currents coming from the other system (B and A);
- the voltages generated by additional current inside the bonding network of the 2 systems (RG6) do not reduce their noise immunity (reduction of the immunity of the asymmetrical links which are referenced to ground);
- the signal cables between the 2 systems (A and B) and MDF will neither suffer from excessive current heating, nor be subject to voltage drop (additional current through RS) which could create transmission faults in the case of asymmetrical links (for example: coaxial cables).

6.1.3 Interconnection between 2 DC/I models

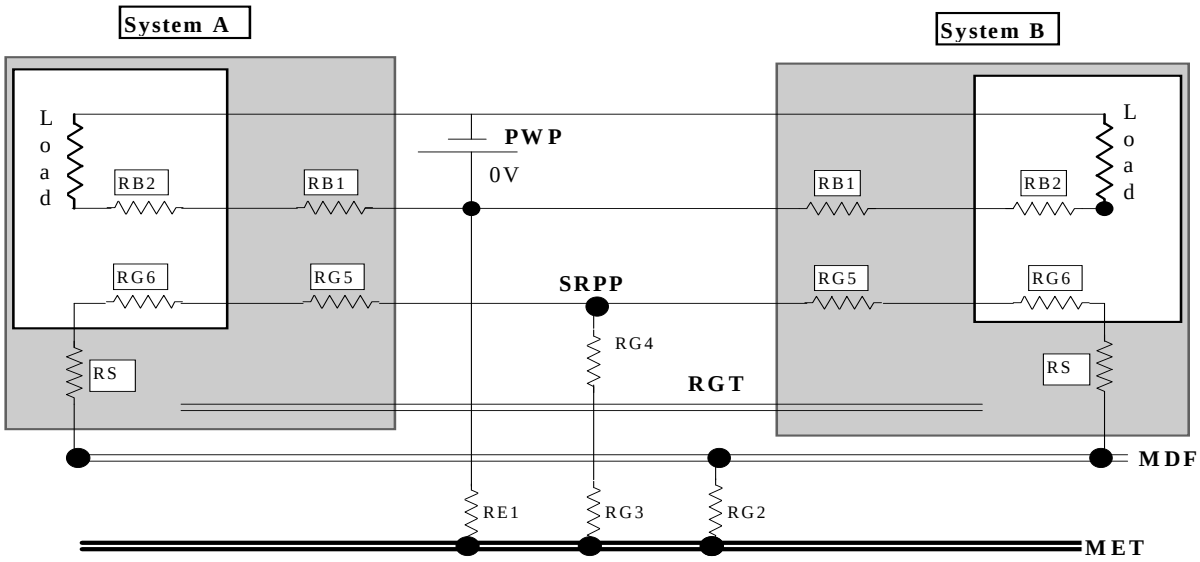


Figure 8: 2 DC/I interconnection

As there is no common path between grounding and power distribution, there is no mutual influence between the 2 systems.

Engineering precautions:

- none.

Annex A (informative): Bibliography

- ETSI EN 300 132-1: "Environmental Engineering (EE); Power supply interface at the input to Information and Communication Technology (ICT) equipment; Part 1: Alternating Current (AC)".
- ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input of Information and Communication Technology (ICT) equipment; Part 2: -48 V Direct Current (DC)".
- ETSI EN 300 132-3: "Environmental Engineering (EE); Power supply interface at the input of Information and Communication Technology (ICT) equipment; Part 3: Up to 400 V Direct Current (DC)".

History

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