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| Project: | **IEEE 802.3 – DTE Power over MDI Working Group** |
| Title: | **Draft proposed text for DTE Power section** |


Sources:

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Abstract: This contribution provides material for the DTE Power section.

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# 1 DTE Power Via MDI

## 1.1 Overview

### 1.1.1 Scope

Clause 0 describes the Remote Power function that allows a device connected to a CSMA/CD LAN to be powered via MDI from a remote power device. The following areas have been identified as potentially benefiting from power over MDI:

- IP telephony
- Web cameras
- Wireless access point
- Industrial automation
- Home automation
- Security Access Control and Monitoring Systems
- Point of Sale Terminals
- Lighting Control
- Gaming and Entertainment Equipment
- Building Management

Remote Power is supplied over the data pairs and/or the spare pairs of the link segment, from a power source to the power sink. A discovery mechanism provides a detection function, to recognize amongst the various 10-BASE-T, 100BASE-TX and 1000BASE-T compatible devices those who have been designed to be remotely powered, either for normal operation or for backup purposes.

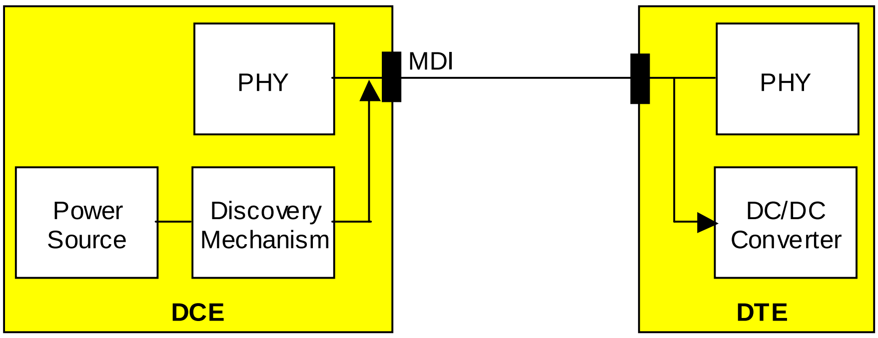



**Figure 1-1. – High-level model**

Power source and discovery mechanism might be implemented inside the DCE (hub, switch, etc.), but mid-span insertion is also possible and covered by this standard.

DTEs that are locally powered, and that do not make use of the remote power are normally not remotely powered. Specific use of remote power for maintenance operation of this kind of DTE are left open to the implementors.

DTEs that are locally powered, and that make use of the remote power are normally remotely powered.

The discovery mechanism is in charge of recognizing if the DTE needs to be remotely powered or not and to control power injection over MDI. The basic mechanism to achieve identification of the category of DTE is to make impedance measurements of the termination. Measurements are performed under direct and under alternative voltage test sequences.

The discovery mechanism remains active, to allow for a dynamic configuration of the installation: as an example, a DTE requiring remote power might be disconnected and replaced later on by another DTE that does not need remote power. These changes in the configuration need to be detected, and the power sending mechanism need to react accordingly.

To maintain interoperability with existing CSMA/CD devices, the function recognizes 10BASE-T, 100BASE-RX and 1000BASE-T compliant equipment. A device that does not show the right impedance will not be remotely powered, and link integrity is provided.

Intermediate devices may need to be powered via the MDI, and in turn pass power on to an end point. These intermediate devices will be required to facilitate the economic mass deployment of VoIP telephones. This is illustrated in figure 1.2

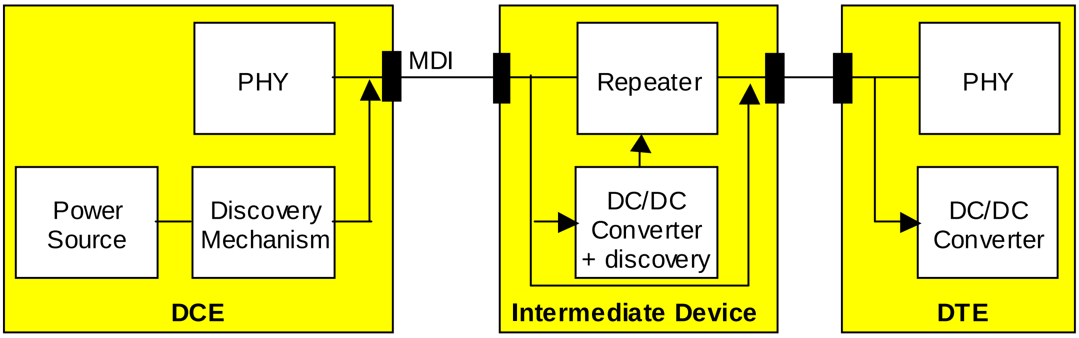



**Figure 1-2. - Remote power of/through intermediate device**

### 1.1.2 Application perspective/objectives

The Remote-Power function is designed to allow IEEE 802.3 compatible devices using an eight-pin modular connector to self-configure a segment for the provision of power over MDI.

The following are the objectives of Remote-Power:

a) Economically provide power to 10BASE-T and 100BASE-TX devices, and consider powering 1000BASE-T

b) Select one power distribution technique for world-wide use

c) Must not cause damage and interoperate with compliant RJ-45 MDI Ethernet devices, including switch-to-switch connections (both supplying power), cross-over cables, common mode termination implementations, shorted conductors, pairs or loopback plug

d) Must have a capability detection function that works with a powered and a unpowered device

e) Add appropriate management objects for power capability and status

f) Support current standard, 4-pair, horizontal cabling infrastructure for installed Cat 3 and Cat 5 cabling

g) Must preserve the signal transmission and isolation characteristics of existing equipment and cabling

h) Must do no harm to 1000BASE-T

i) Must allow upgrade of a link from a non-powered to a powered solution by the use of external equipment (mid-span power insertion)

j) Consider interaction with other RJ-45 interfaces: Token Ring, ATM, FDDI, TP-PMD, 1000BASE-T, ISDN, network test equipment, PBX
k) Reasonable and cost-effective to implement
l) Must consider intermediate devices that are powered via the MDI, and in turn pass power on to an end point
m) Must be capable of operation in the absence of Network Management
n) Must operate with DTEs that are already locally powered (backup or maintenance)
o) Must operate properly when the DTE is electrically connected, powered up, reset, disconnected, replaced by either category (to be powered or not) of DTE
p) Must not cause corruption of IEEE 802.3 Layer Management statistics
q) Operates using a peer-to-peer master/slave mechanism
r) Must not impact EMI/RFI emissions

### 1.1.3 Relationship to ISO/IEC 8802-3

The Remote-Power over MDI is provided at the Physical Layer of the OSI reference model

### 1.1.4 Compatibility considerations

The remote powering over MDI is designed to be compatible with 10BASE-T and 100BASE-TX UTP, and do not harm to 1000BASE-T, with no changes to the existing MAC client interface. It is backwards compatible and interoperable with 10BASE-T, 100BASE-TX and 1000BASE-T compliant devices. The proposed standard will conform to 802 Functional Requirements.

Implementation of the Remote Power over MDI is optional. For CSMA/CD compatible devices that use the eight-pin modular connector of ISO/IEC 8877:1992, if Remote Power is required, either for normal operation or for power backup operation, then the Remote Power over MDI shall be used in compliance with clause 0. If the implementor of a non-CSMA/CD eight-pin modular device wishes to assure that its operation does not conflict with CSMA/CD devices, then adherence to clause 0 is recommended.

## 1.2 Functional specifications

### 1.2.1 Remote powering

Current is injected via the center taps of a transformer, using a Phantom Power method on the TX and RX pairs. In addition, current can be injected on the spare pairs in particular in case of terminals that need more power. The overall description of the remote power is given in figure 1.3

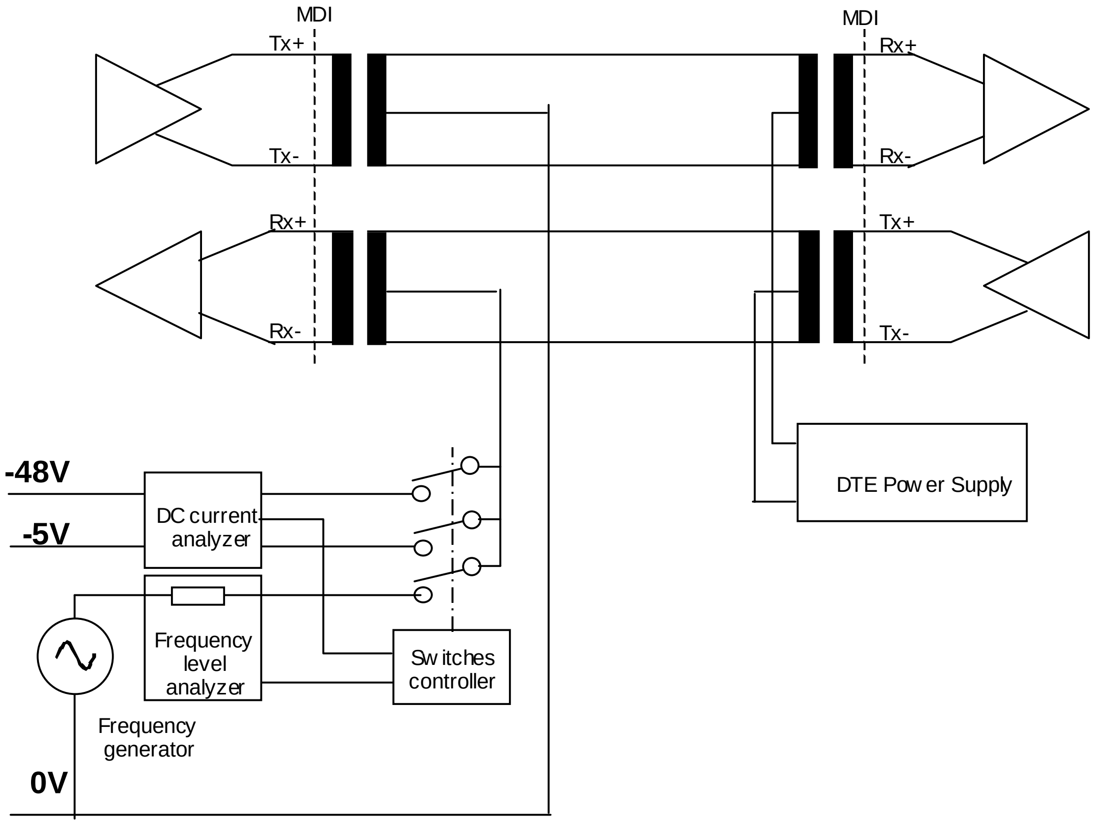



**Figure 1-3. - Remote power injection and discovery functions**

### 1.2.2 DTE impedance

The discovery function makes measurements to checks the presence of capacitor C1 (see figure 1.4, 1.5 and 1.6). A terminal designed to be powered from the link just needs to have this particular input impedance. The following figures illustrate the cases where the DTE has already a local power or not, with simple or sophisticated protection against reverse polarity.

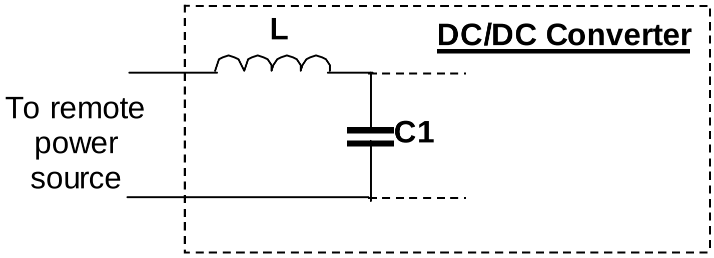



**Figure1.4. Terminal without local power source**

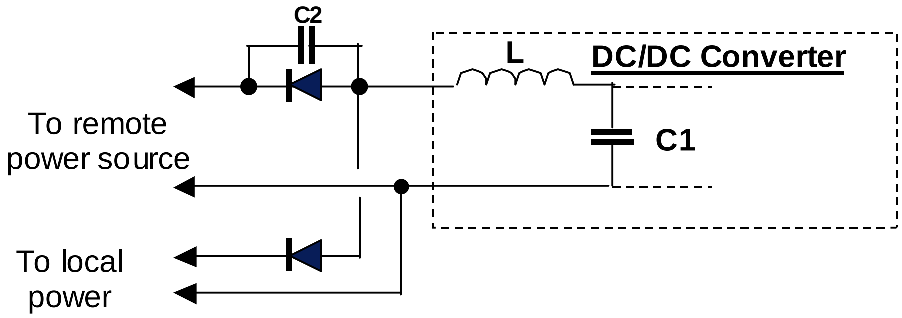



**Figure 1.5. Terminal with local power, and simple protection**

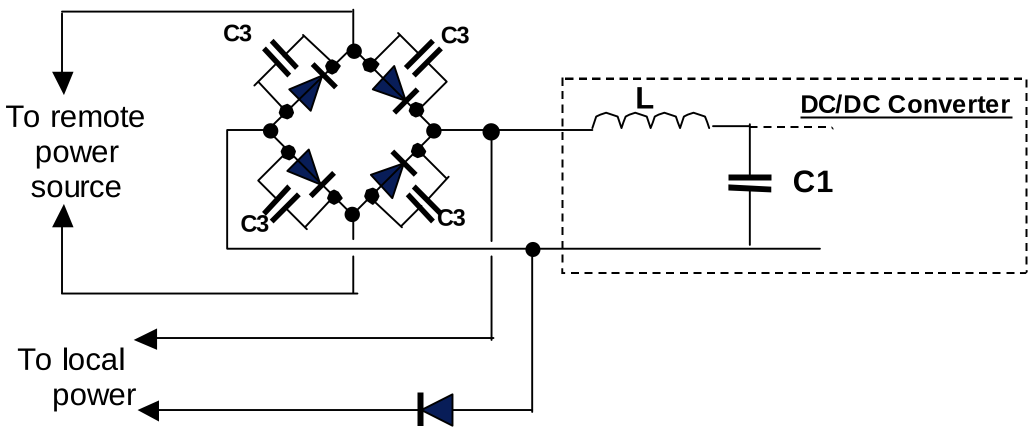


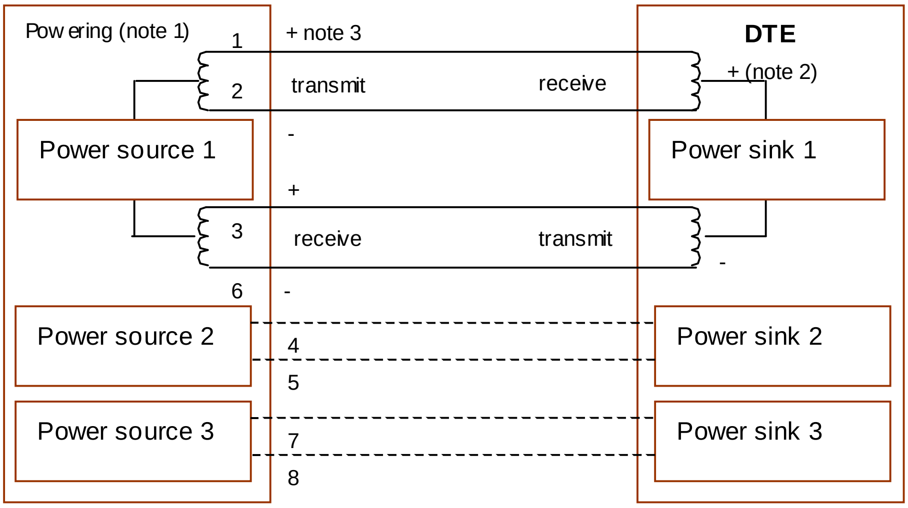

**Figure 1.6. DTE with local power and protection including possible reverse polarity**

### 1.2.3 Configuration with multiple power distributions

In addition to the main power distribution, using phantom mode over the data pairs, additional power distribution may be provided over the spare pairs. This is useful in particular in the following cases:

- to cope with terminals that were designed to be powered through spare pairs
- to provide more power when needed

The reference configuration for the double power feeding is described in Figure 1.7. The access lead designations a to h reflect pin assignment, which are specified in clause XXX. The use of leads a,b,c and d is mandatory. The use of leads e,f,g and h is optional.




Note 1: hub or switch that provides power to the DTE
Note 2: this symbol refers to the polarity of power during normal conditions
Note 3: this symbol refers to the polarity of data pulses

**Figure 1.7. Reference configuration for multiple power sources**

**System consideration for multi-segment operation**

Intermediate devices like repeaters may need remote power to ensure operation even when local electrical power is down. This is depicted in figure 1.8, where

- remote power is passed through the repeater
- the repeater is also fed via phantom
- the discovery process recognizes the DTE to be fed from the source

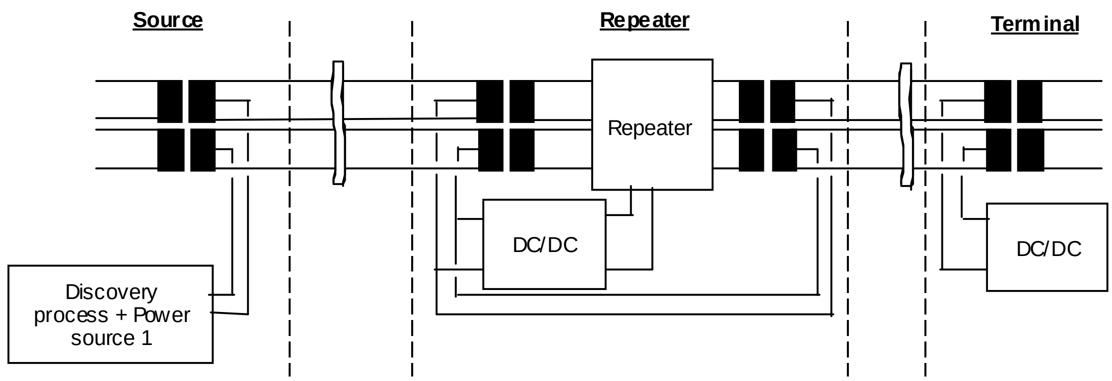



**Figure 1.8. - Remote power of / through a repeater**

There are cases where more power is needed due to the intrinsic consumption of the intermediate equipment, and to the increase of the length of the link and subsequent line loss. In these cases, power sources 2 and 3 may be "wired-or-ed":

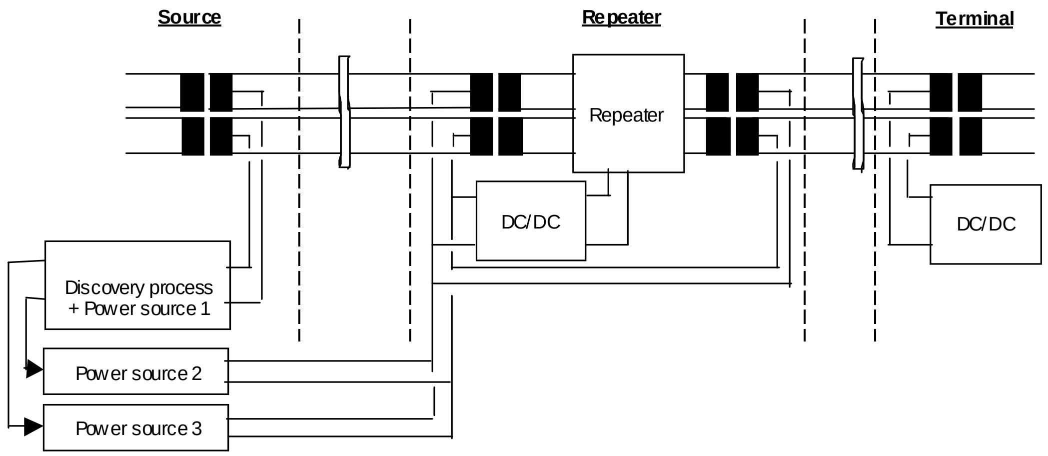



**Fig 1.9. - Remote power with several power sources**

The additional power sources may also be used in conjunction with a discovery mechanism in the intermediate equipment to provide remote power through a hub.

### 1.2.4 Mid-span insertion

Mid-span insertion is the solution to upgrade an existing installation without changing the hub or the switch. It is described in figure 1.10. Power is sent outside the switch or hub, and uses spare pairs so as to avoid any interaction with data pairs.

To cope with both solutions (phantom mode over data pairs and direct mode over spare pairs), the terminal shall be designed to receive power in both modes.

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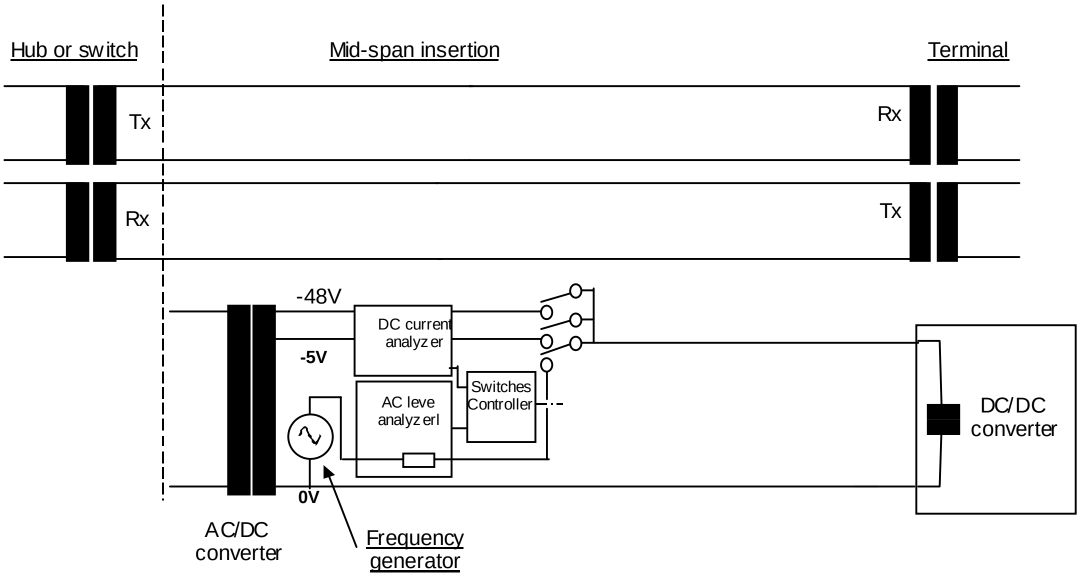


**Figure 1.10. - Mid span insertion over spare pairs**

#### 1.2.5 Discovery function

The discovery function determines the category of DTE that is connected. The main principle of the discovery is based on a measurement of the impedance of the link, so as to be able to detect

- A capacitance, which is the signature of a terminal that is equipped for remote power
- Another impedance (e.g. Bob Smith termination) for a terminal that do not need remote power
- Short circuit
- Open circuit
- Together with any change occurring later on (terminal disconnected, replaced by a DTE that does not need to be powered, short circuit repared, etc. )

### 1.3 State diagram and variable definitions

The Discovery shall implement the state diagram as depicted in figure 1.12. Additional requirements to this state diagram are left open to the implementor.

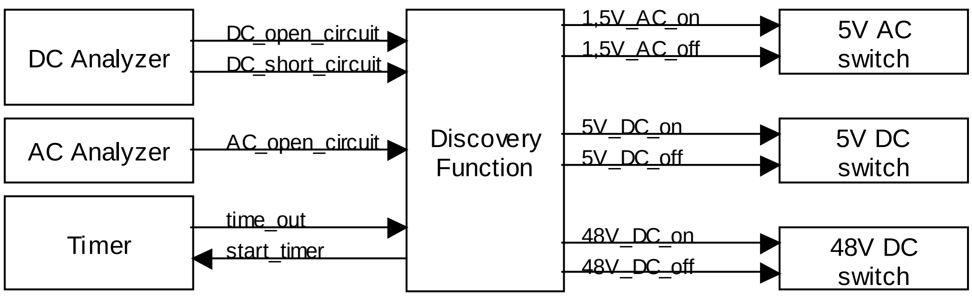


**Figure 1.11. Functional reference diagram**

#### 1.3.1 State diagram variables

| | |
|---|---|
| DC_open_circuit | Indicates infinite impedance seen from the DC analyser. |
| DC_short_circuit | Indicates an impedance below 50 ohms seen from the DC analyser. This occurs in particular when a problem occurs on the DTE or on the line |
| AC_open_circuit | Indicates infinite impedance seen from the AC analyser. |
| 1,5V_AC_on / _off | 1,5 V AC switched on / off |
| 5V_DC_on / _off | 5 V DC switched on / off |
| 48V_DC_on / _off | 48 V DC switched on / off |

#### 1.3.2 State diagram timers

**Table 0.1. Timer value summary**

| Parameter | Min | Max |
|---|---|---|
| Timer1 | 150ms | 500ms |
| Timer2 | 30s | 60s |

### 1.3.3 State diagram

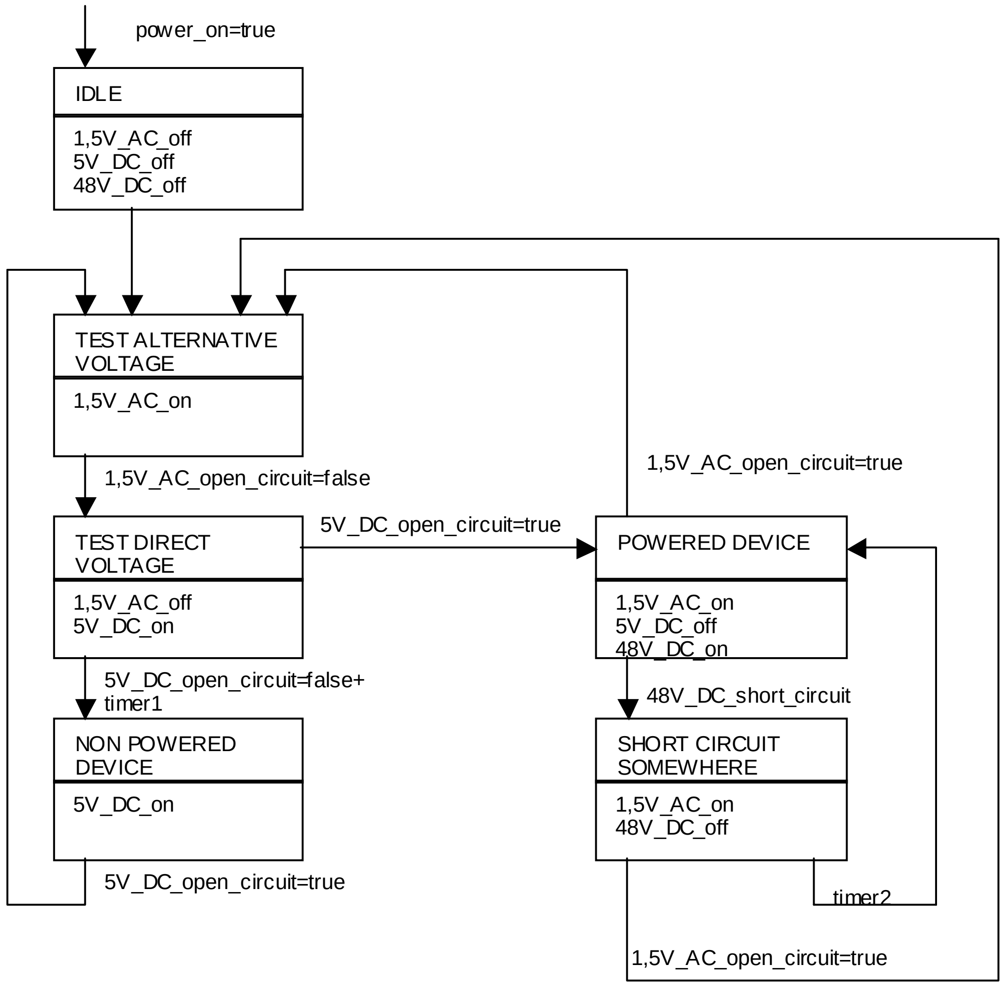


**Figure 1.12. Discovery state diagram**

## 1.4 Electrical specifications

### 1.4.1 Power source

#### 1.4.1.1 Power source nominal voltage

Under normal power conditions the nominal value of the voltage of power source 1, at the output of the device shall be 48V ± 6V

The nominal value of the voltage of power sources 2 and 3, if provided shall meet the same requirement

### 1.4.2 Power available at DTE

Under normal power conditions, the maximum voltage at the interface of a DTE shall be 48 ± 6V and the minimum voltage shall be 28 V when drawing a power of up to the maximum permitted power consumption

Power sources 2 and 3: under study

#### 1.4.2.1 Power source consumption

Under normal power conditions, a DTE which draws power from power source 1 shall draw no more than 10 W.

Power sources 2 and 3: under study

#### 1.4.2.2 Current transient

The rate of change of current drawn by a DTE from power source 1 shall not exceed 20 mA/µs

This requirement is not applicable during 100 ms or at time C according to figure 1.12 as elapsed after the connection of the terminal

#### 1.4.2.3 Current/time limitations for DTE power sink

To limit the current that each terminal can sink from the phantom circuit connected to power source 1 in the normal power condition, the terminal shall conform to the mask given in figure 1.12, with the values given in table 1.2, when tested in accordance with figure 1.13

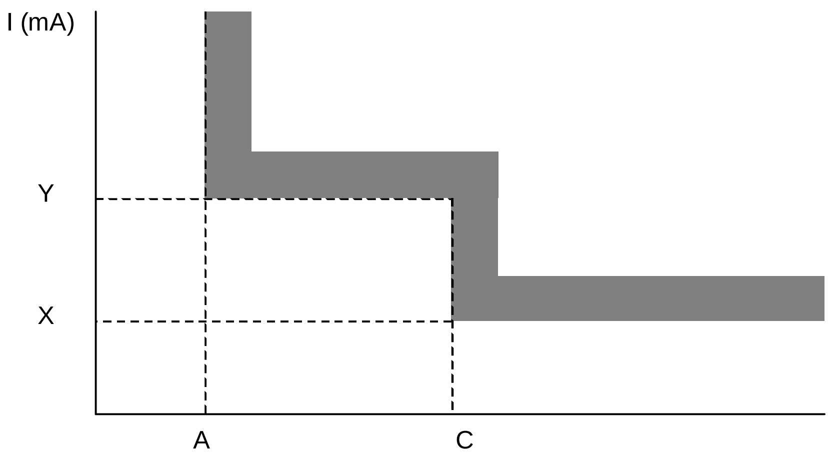


**Figure 1.13.: Current/time limitations for DTE power sink**

**Table 1.2: Parameters for the normal condition**

| | | | |
|---|---|---|---|
| A | 5 µs | Y | 1A |
| C | 100 ms | X | Current equivalent to 12.25 W never exceeding 350 mA independent of the input voltage |

Note: the total capacitance at the power source 1 input to the DTE is expected to be less than 220 µF under all conditions of normal operation.

The measurement is made based on the test circuit as described in figure 1.13

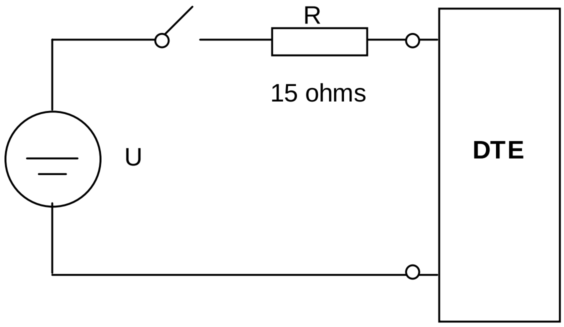


**Figure 1.14. Test circuit for current/time limitation**

## 1.5 Safety

All equipment meeting this standard shall conform to IEC 950 ed 3, UL1950 ed 3 and CSA950 ed 3