

Data Center High Voltage DC

- High Voltage DC has existed in the Data Center for some time
- HVDC is common on the battery bus for high end UPS.
- APP touch safe 600V connectors are used in many of these applications



High Voltage DC Battery



APP Powerpole connector
APC HVDC battery module



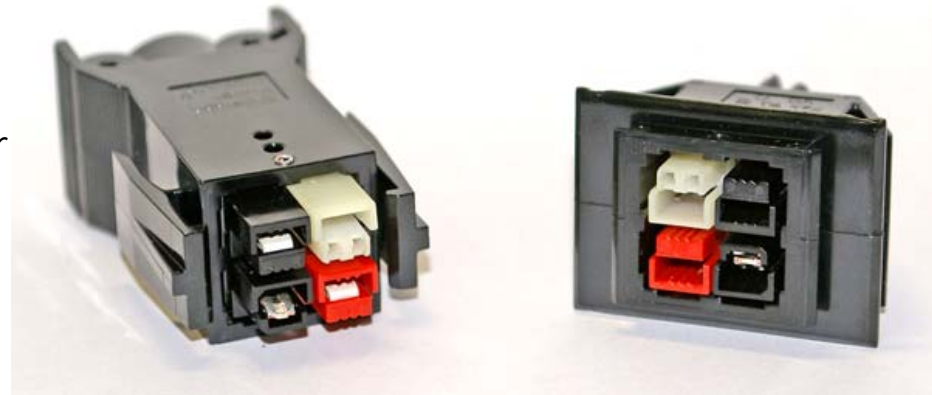
APP connector for APC HVDC
extended run battery packs

Requirements for 400 DC connectors

- 600V UL rating
 - UL class for connectors <150V, <300V, <600V, <1000V
- Touch safe connector for hazardous voltage
 - Meeting IP20 and UL 1977, 10.2 in unmated condition
- UL rated first mate- last break grounding circuit
 - For 10 awg, 750A 4 sec
- Other considerations
 - Hot swapping
 - Contacts handle load
 - Enabling circuit
 - Latching or locking
 - Keying capability for different amperage levels
 - Size compatibility with IEC 320 inlets

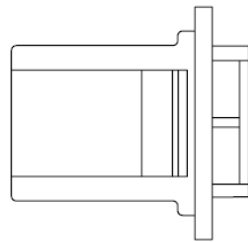
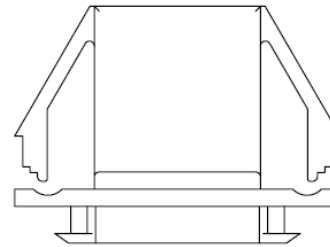
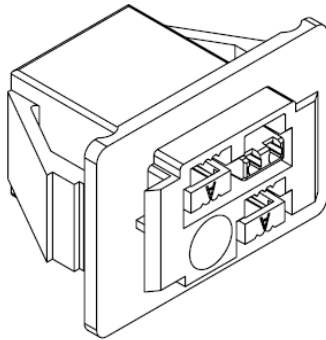
APP Connector

- 600 VDC rated
- Touch safe power circuits
- UL 10A and 30A ground contacts
- Hot plug capable
 - ❑ UL rated 30A @110V
 - ❑ Estimate 8A @ 400V
- Prototype 1 to 4 cir signal insert for enabling and/or data
- Positive latch
- Keying capability
- Size compatible with 16A IEC320
 - ❑ Prototype for 10A IEC320 inlet size
- Future options – over molded plug
- Multi-source



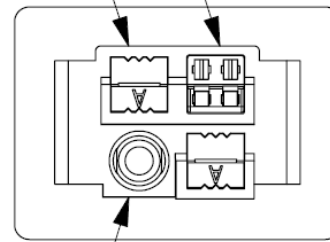
Powerpole Pak

One-piece Powerpole Pak IEC320-C14 Compatible



15-45A FINGER
PROOF (x2)

4-POLE
SIGNAL



10A PIN

Anderson Power Products

- The largest manufacturer of DC power connectors.
- Global ISO 9000 certified manufacturing and logistics
 - Sterling MA USA
 - Fermoy Ireland
 - Hong Kong PRC
 - Songgang (SZ) PRC
- UL and TUV certified client test facility



Sterling USA Warehouse and Administration

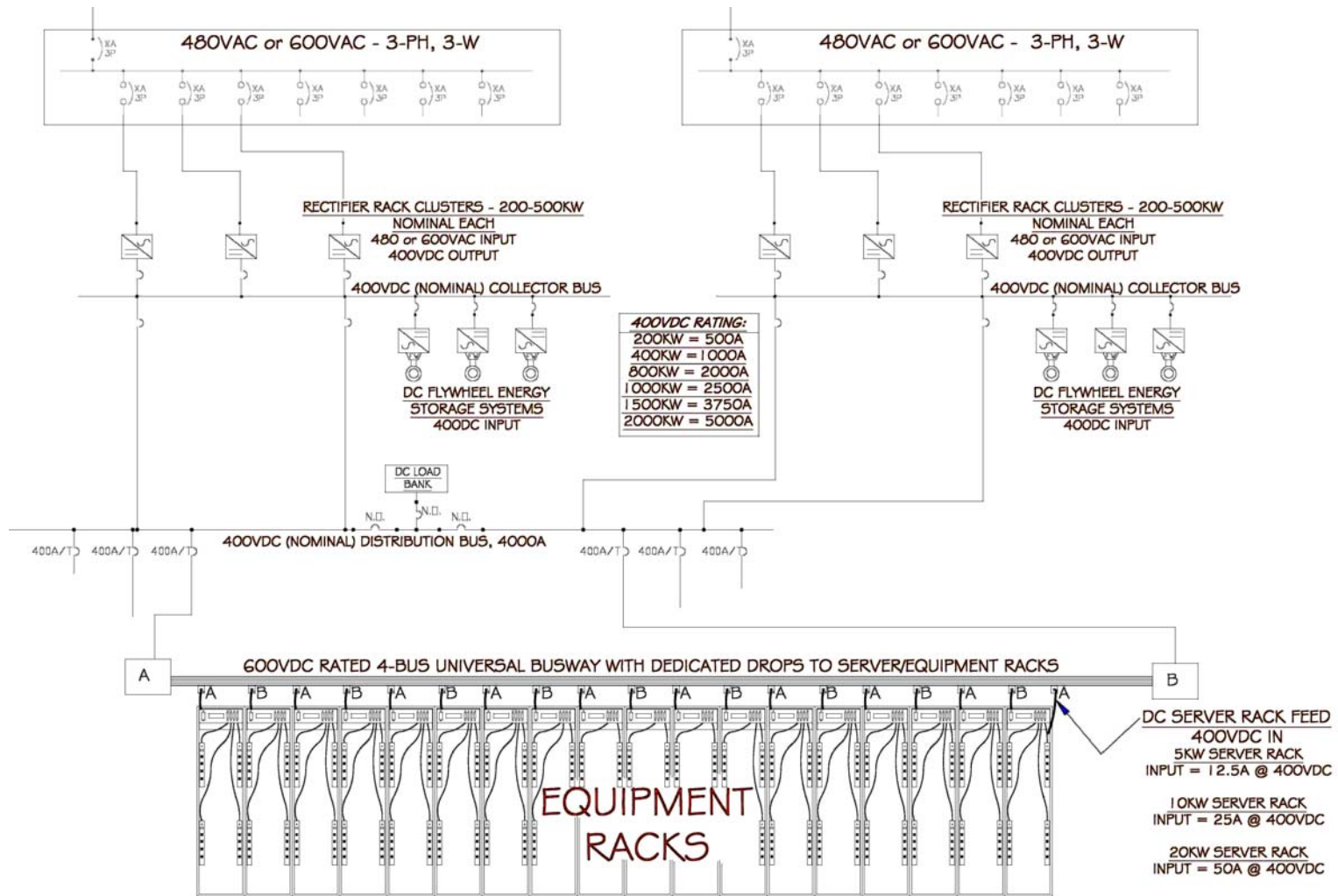


Songgang (SZ) PRC Manufacturing

Contacts/Connectors and Other Hardware Panel:



400VDC DISTRIBUTION SYSTEM



Topics to be addressed :

- Nominal voltage rating of connectors
- Wiring configuration for cord/plugs and connectors
- Receptacle & Plug Physical Design Considerations
- Branch circuit control options



Standards

- What standards exist today for DC connectors?
 - Swedish TC 23
 - IEC Standards
 - IEEE – NEMA – NFPA(NEC) – UL
 - Others?
- Examples from other industries?
 - TELCO
 - Transit
 - Electric Vehicles
 - Military
 - Alternative Energy (Solar – Fuel Cell – Etc..)
 - DC Link in AC UPS
- Proposed Standard = International
- Standardization Process for DC Connectors?



Voltage Rating

- Nominal voltage rating of connectors
 - 600vDC
 - 500vDC
 - 400vDC
 - ????



Wiring Configuration

- Wiring configuration for cord/plugs and connectors
 - Plus, Minus, Ground and Enable
 - Impedance Issues?
 - Cord Rating and Construction



Receptacle & Plug Design

- Receptacle & Plug Physical Design Considerations
 - Base on existing standards for AC connectors - Or develop new configuration that is DC specific
 - Impedance Issues
 - Insertion & Withdrawal Force
 - Contact Metallurgy & Mechanics
 - Contact Resistance / Reliability
 - Contact Wear & Arc Resistance
 - Physical Retention / Locking Receptacle?



Branch Circuit Control

- Branch circuit control options
 - Build in controls to verify system is off before plug or unplug action can occur
 - What is the real arcing hazard exposure?

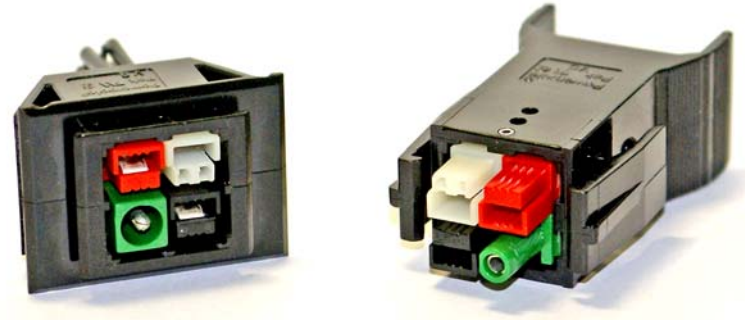
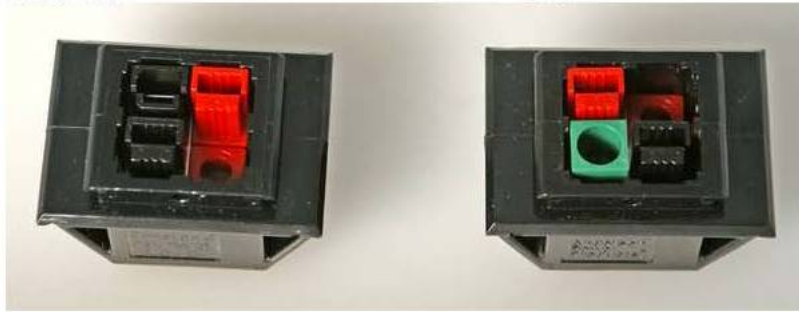


EXAMPLES

PowerPak configurations for 400 VDC

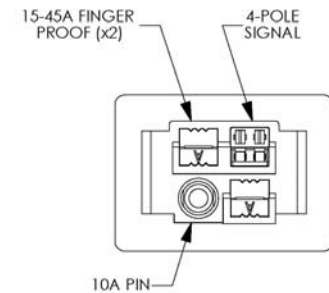
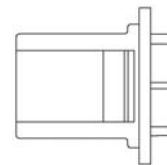
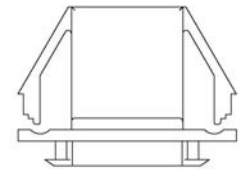
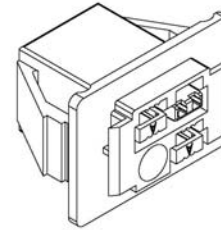
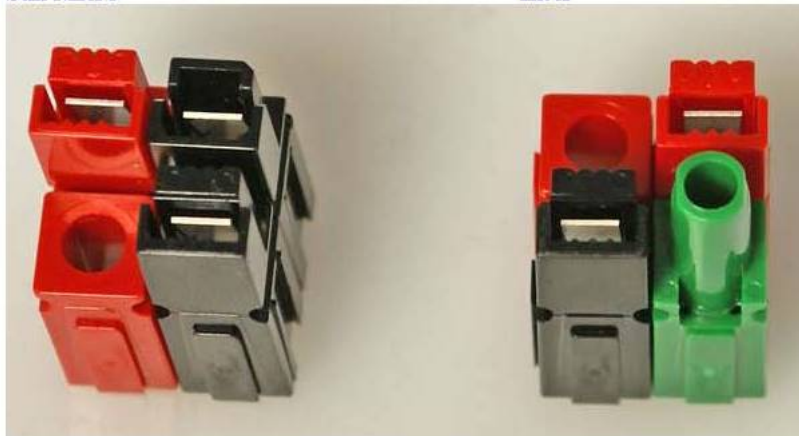
30 amp Receptacle
Sun Micro

10 Amp Receptacle
Intel



30 amp Plug w/latch
Sun Micro

10 Amp Plug w/latch
Intel



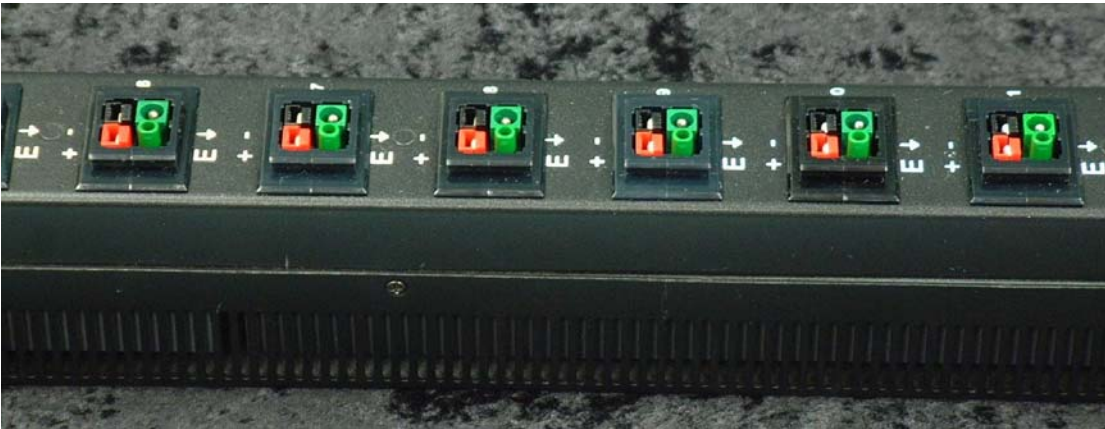
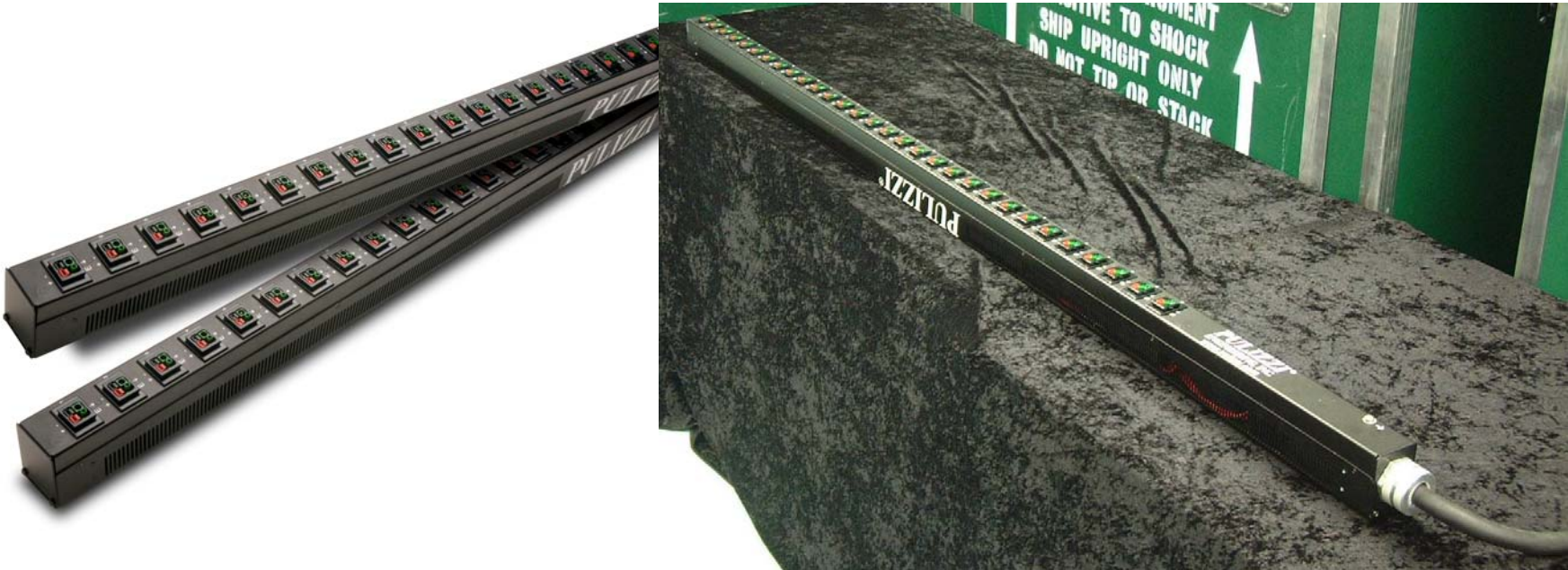
Red spacer location will be replaced by future 4 circuit signal module



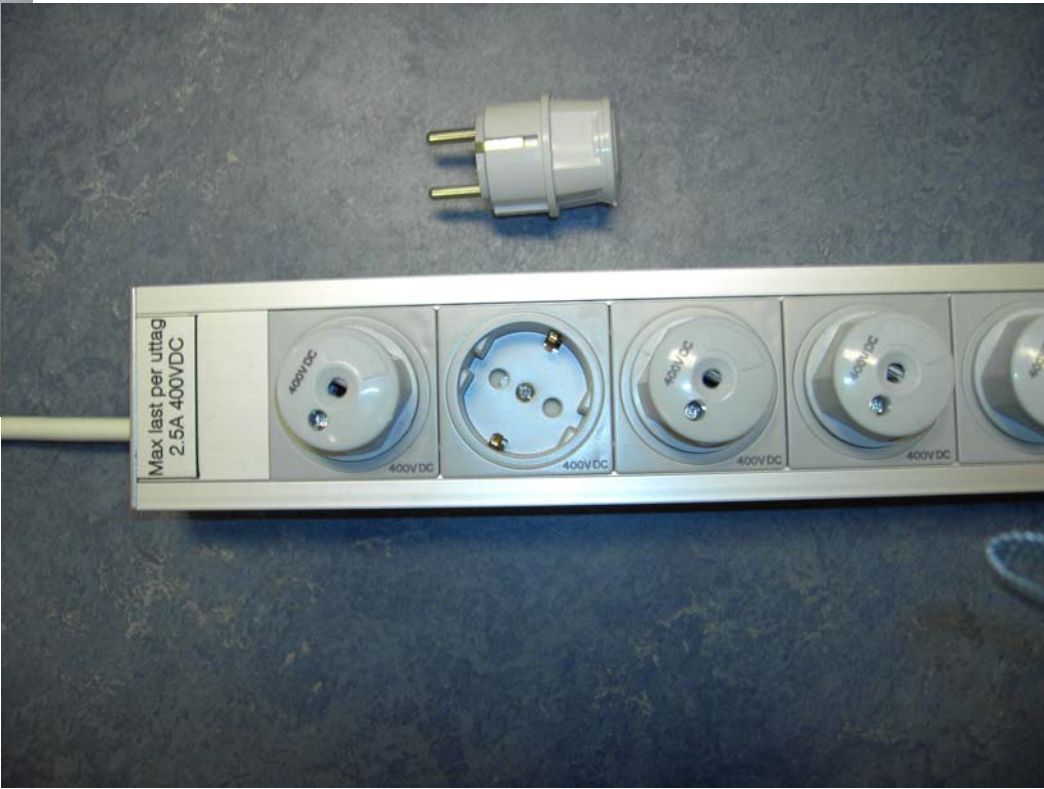
EXAMPLES



EXAMPLES



EXAMPLES



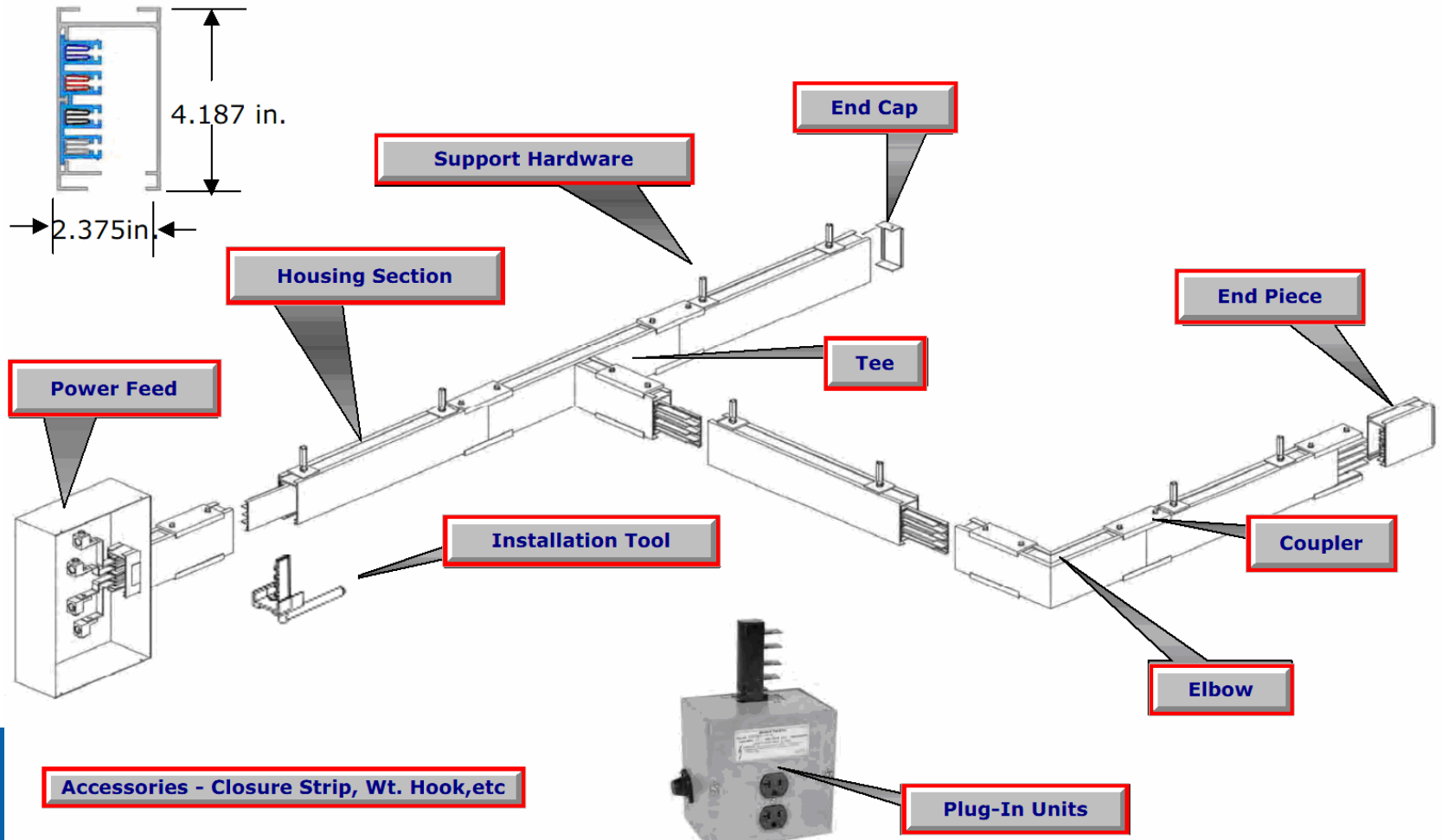
EXAMPLES



Standard B225 Amp System to 600 Volts

Also B160 or 160 Amp Systems

2, 3 or 4 pole with/without Isolated ground



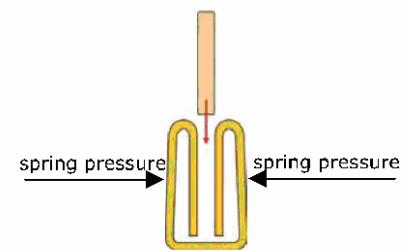
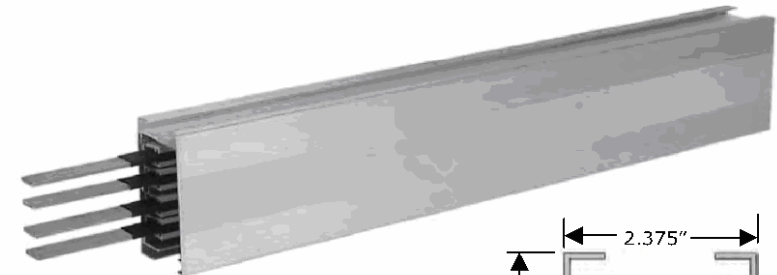
225 Amp

HOUSING SECTIONS

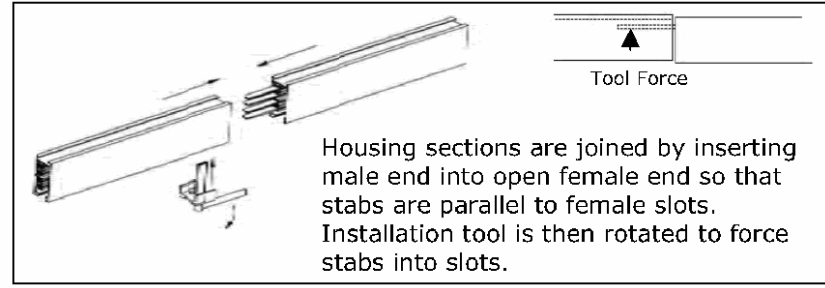
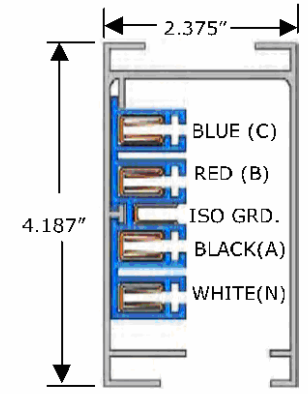


Track Busway housing section consists of an extruded aluminum shell with "spring-pressure" type copper channel busbars contained in a full length PVC insulator mounted on one side on the interior wall. The aluminum extrusion acts as a 100% ground path meeting UL 857 Standard and complies with applicable paragraphs of Section 250 of the NEC. Each housing has an open access slot over its entire length for the insertion of turn-n-lock plug-in units.. Housing configurations include 2, 3 and 4 pole varieties with 600 Volt maximum rating. Each housing section has male stabs protruding at one end which fit into the channels of the adjoining section. Installation tool is used to force the stabs into the busbar channels for a solid "spring-loaded" electrical connection.

- MATERIAL:** Extruded Aluminum 6005-T5 unpainted
- RATINGS:** 100% Ground Path 225 Amp, 600 Volt
- LENGTH:** 5 Ft, 10 Ft, 20 Ft.
- INSULATION:** PVC
- VOLTAGE DROP:** distributed load Single Phase 40ft (.8PF)



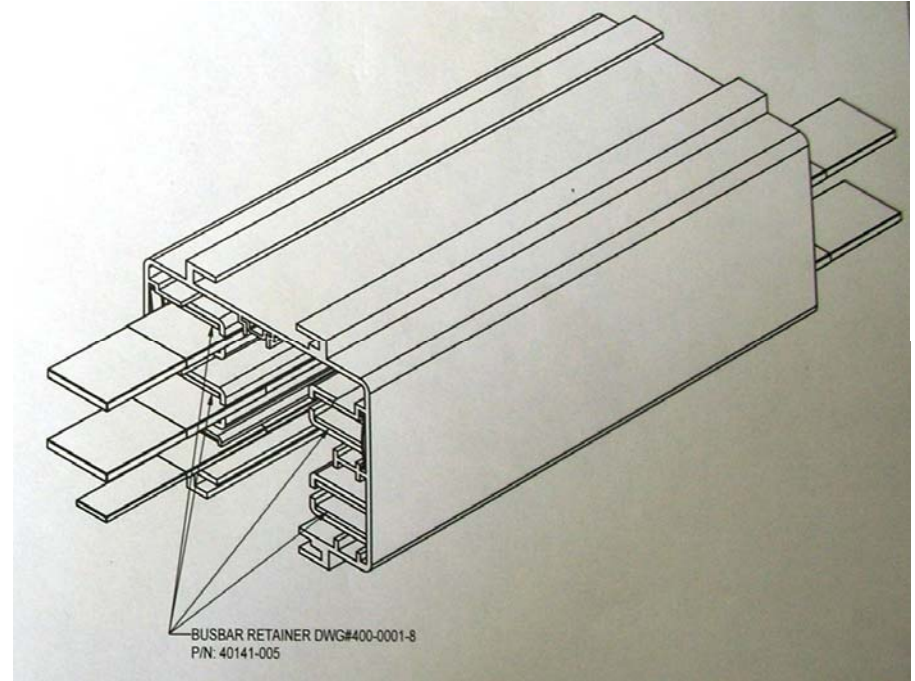
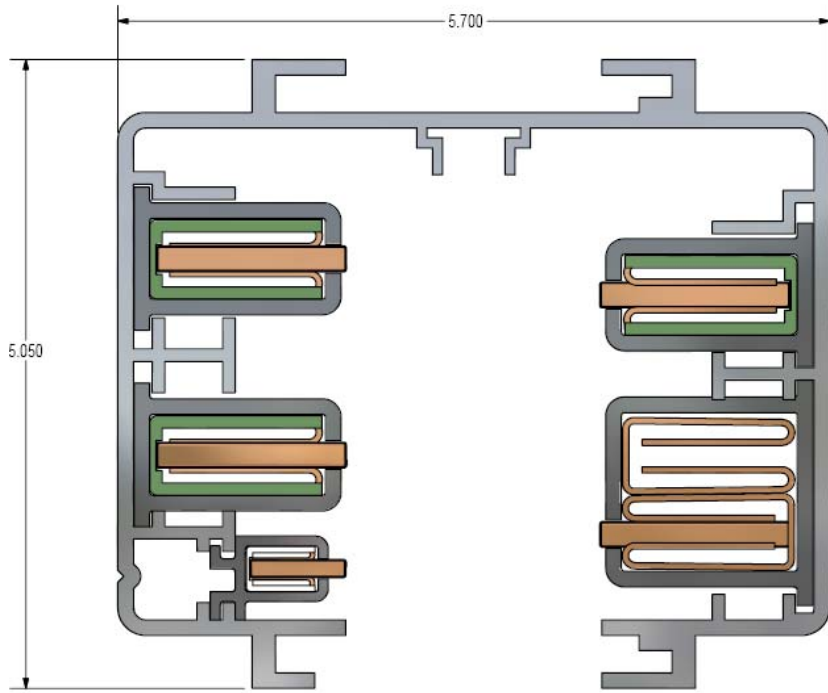
"Spring-pressure" channel busbar



Housing sections are joined by inserting male end into open female end so that stabs are parallel to female slots. Installation tool is then rotated to force stabs into slots.



NEW BUSWAY IS RATED AT 400Amps AT 600V DC



DC RATED BUSWAY PLUG FOR HVDC POWER DROP



SVENSK STANDARD (Swedish standard) SS 428 08 34

15 Interlocked socket-outlets

Socket-outlets interlocked with a switch shall be constructed in such a way that a plug cannot be inserted into or completely withdrawn from the socket-outlet while the socket-contacts are live, and the socket-contacts of the socket-outlet cannot be made live until a plug is almost completely in engagement.

Compliance is checked by inspection and by manual test.

NOTE Other test requirements are specified in IEC 60884-2-6.

Propose to change by:

15 Interlocked socket-outlets

This clause of SS-IEC 60884-1 is applicable.

Draft new text for UC (universal) and DC interlocked socket-outlets for SS 428 08 34

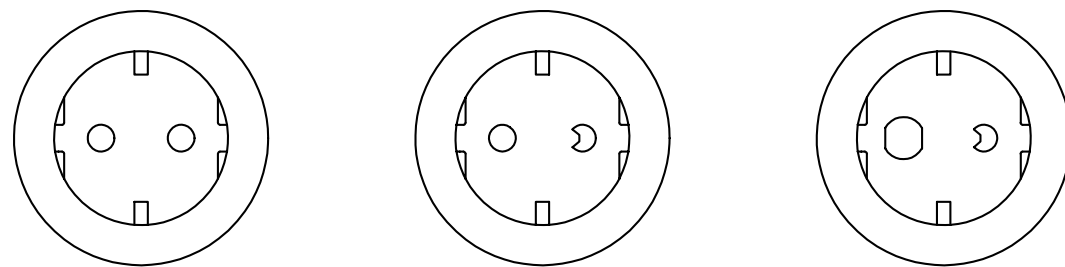
Socket-outlets for UC and DC might be designed for 16 A current maximum.

Plugs for loads for UC and DC rated for up to 2,5 A can be connected and disconnected without interlocking. Plugs for 2,5 A are rated for UC and DC without interlocking mechanical or electronic functions.

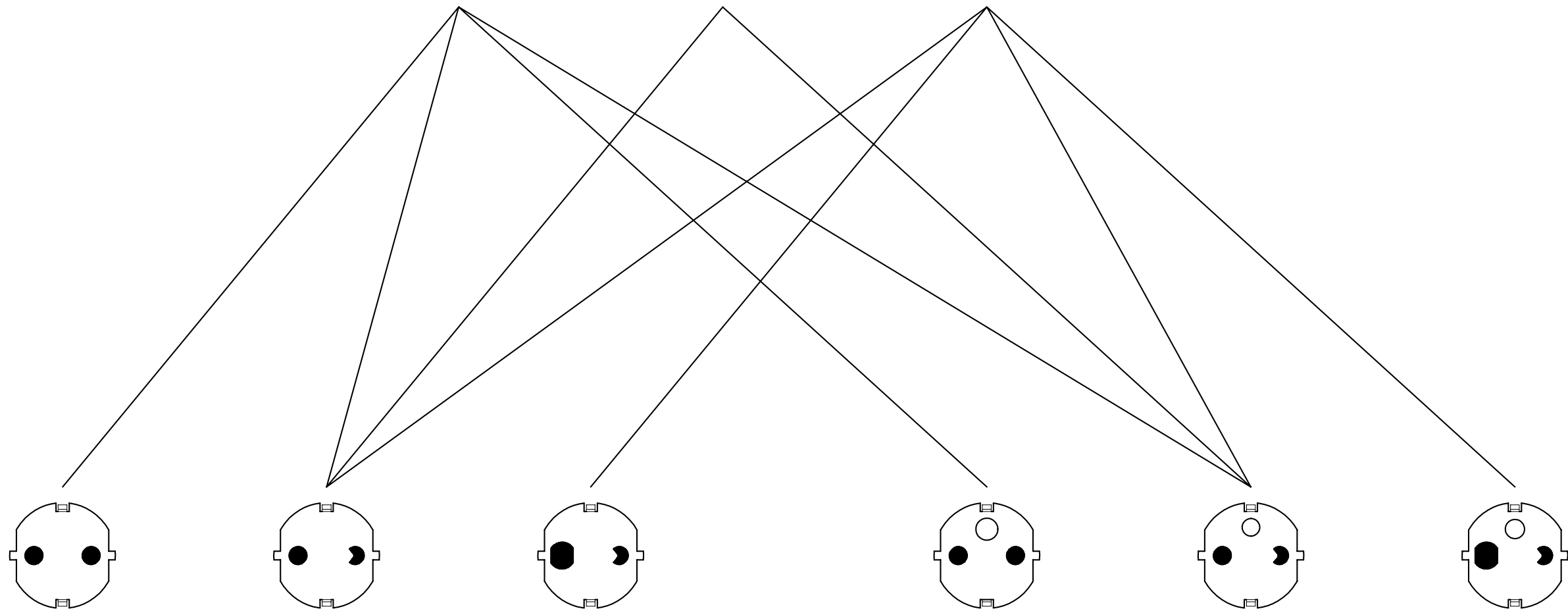
For loads higher than 2,5 A, the standard UC and DC plug can be used if it is equipped with a mechanical or electronic interlocking switch function with or without connection to the outlets cover. The function shall be designed in such a way that a plug cannot be inserted into or completely withdrawn from the socket-outlet while the plug-contacts can carry current, i.e. the plug-contacts shall be switched off from the load or high-ohmic during these procedures.

Existing	New	New
16/250 AC	16/250 AC 10/400 DC	10/400 DC
III	IIIb	IIIc

Socket-outlets



Plugs



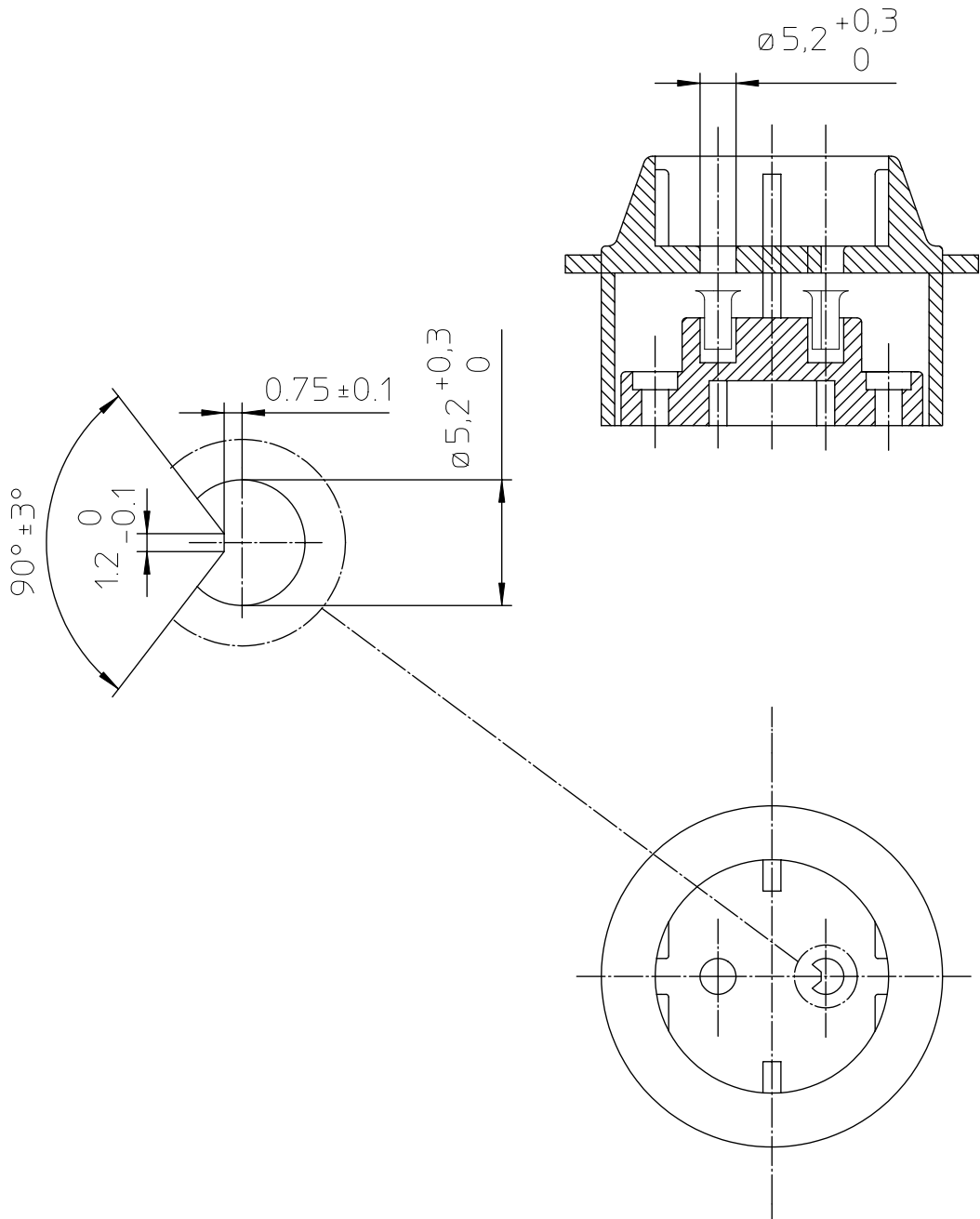
IV	IVb	IVc	VII	VIIb	VIIc
16/250 AC	16/250 AC 2,5/400 DC without interlock	2,5/400 DC without interlock 10/400 DC with interlock	16/250 AC	16/250 AC 2,5/400 DC without interlock	2,5/400 DC without interlock 10/400 DC with interlock
Existing	New	New	Existing	New	New

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STANDARD SHEET III b

16A/250 V AC
10 A/400 V DC

DC Two-pole socket-outlet with side earthing-contacts
for power supply of AC/DC equipment



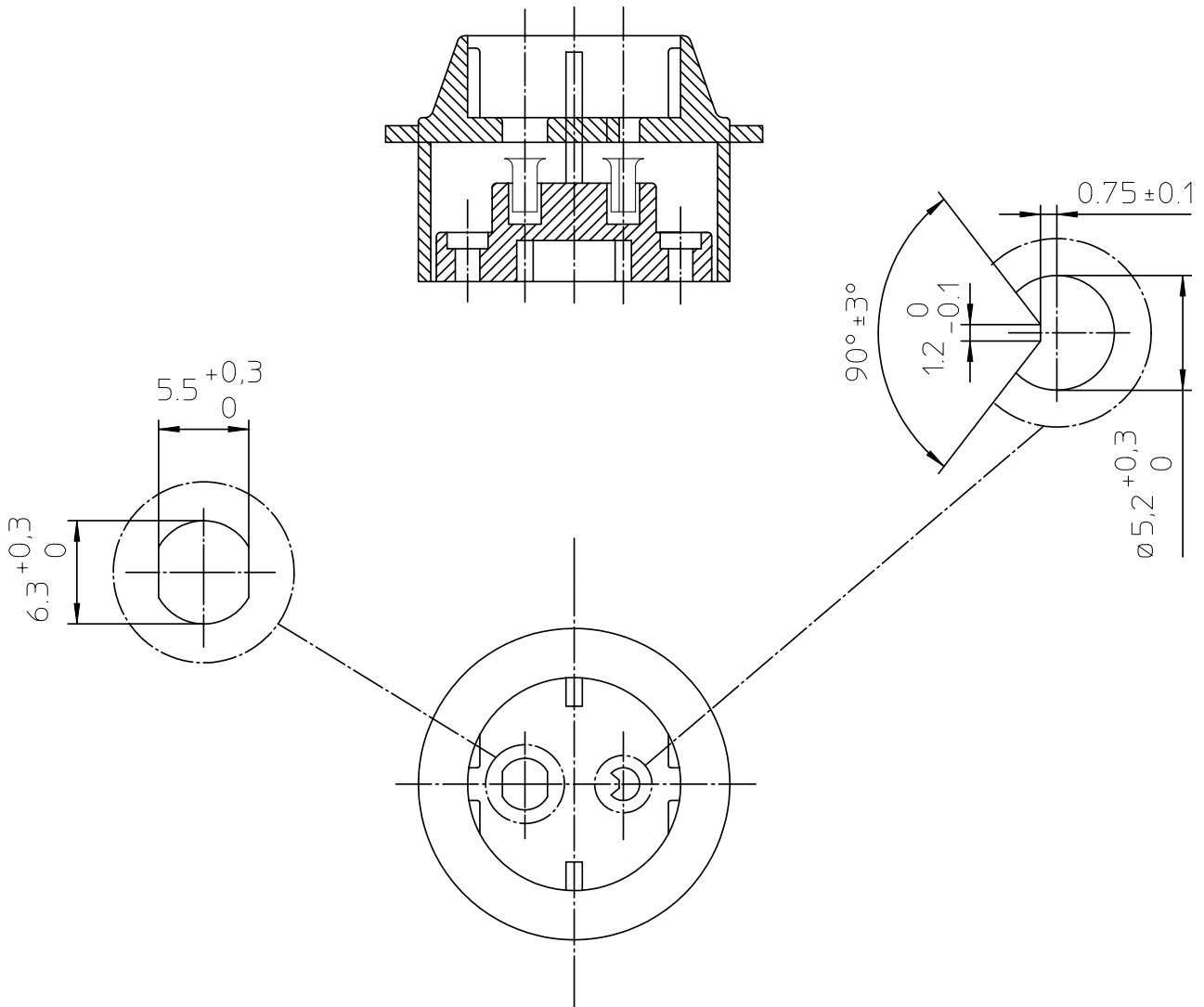
For other dimensions and specifications see standard sheet III.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

DRAFT

STANDARD SHEET III c

10 A/400 V DC

Two-pole socket-outlet with side earthing-contacts
for power supply of DC equipment



For other dimensions and specifications see standard sheet III.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

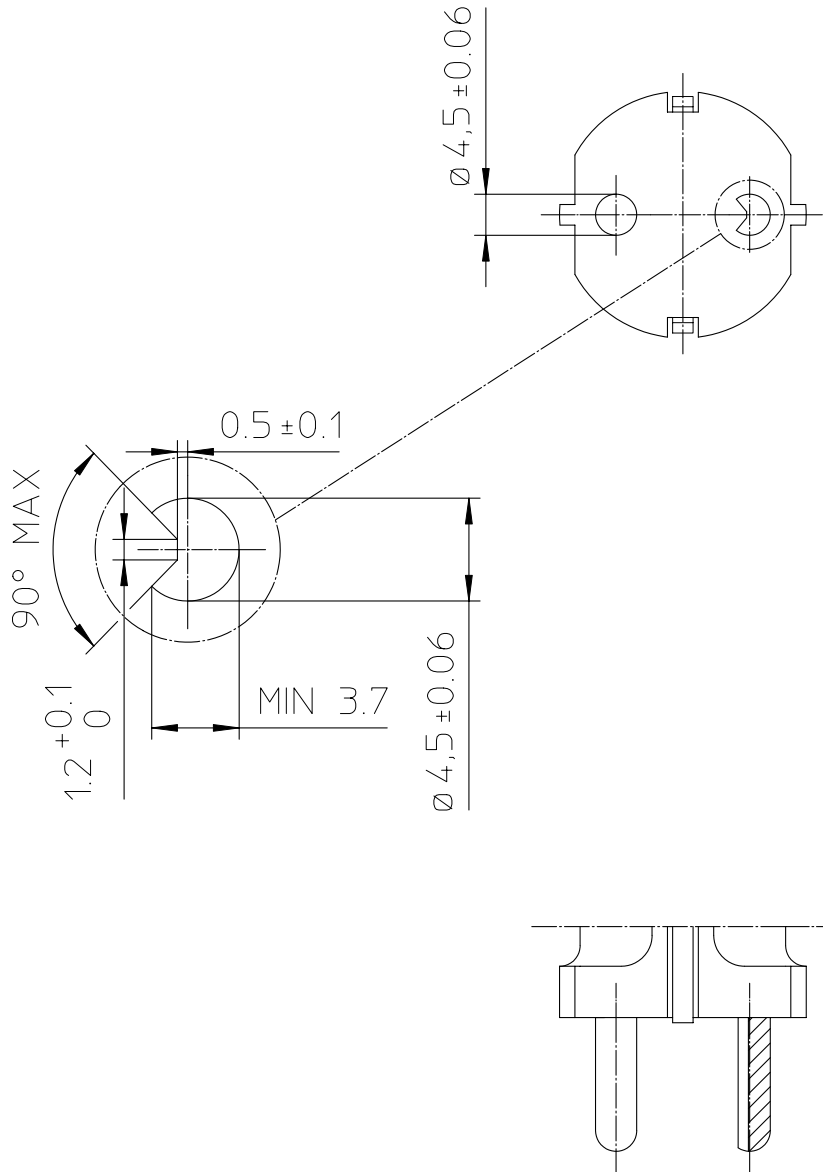
DRAFT

STANDARD SHEET IV b

16A/250V AC
2,5A/400V DC
without interlock

16A/250V AC
10A/400V DC
with interlock

DC Two-pole plug with side earthing-contacts
for power supply of AC/DC equipment



For other dimensions and specifications see standard sheet IV.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

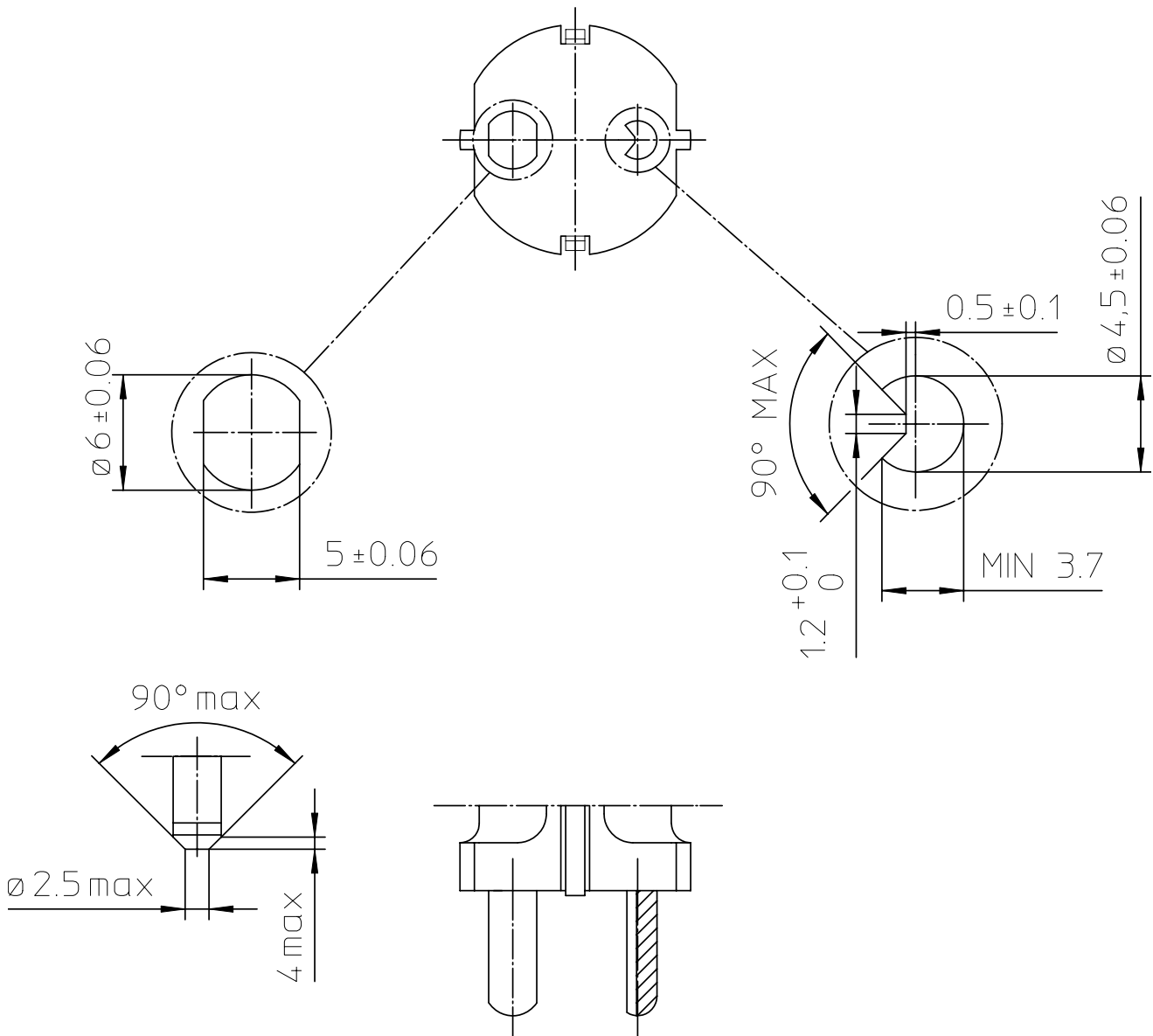
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STANDARD SHEET IV c

2,5A/400V DC
without interlock

10A/400V DC
with interlock

Two-pole plug with side earthing-contacts
for power supply of DC equipment



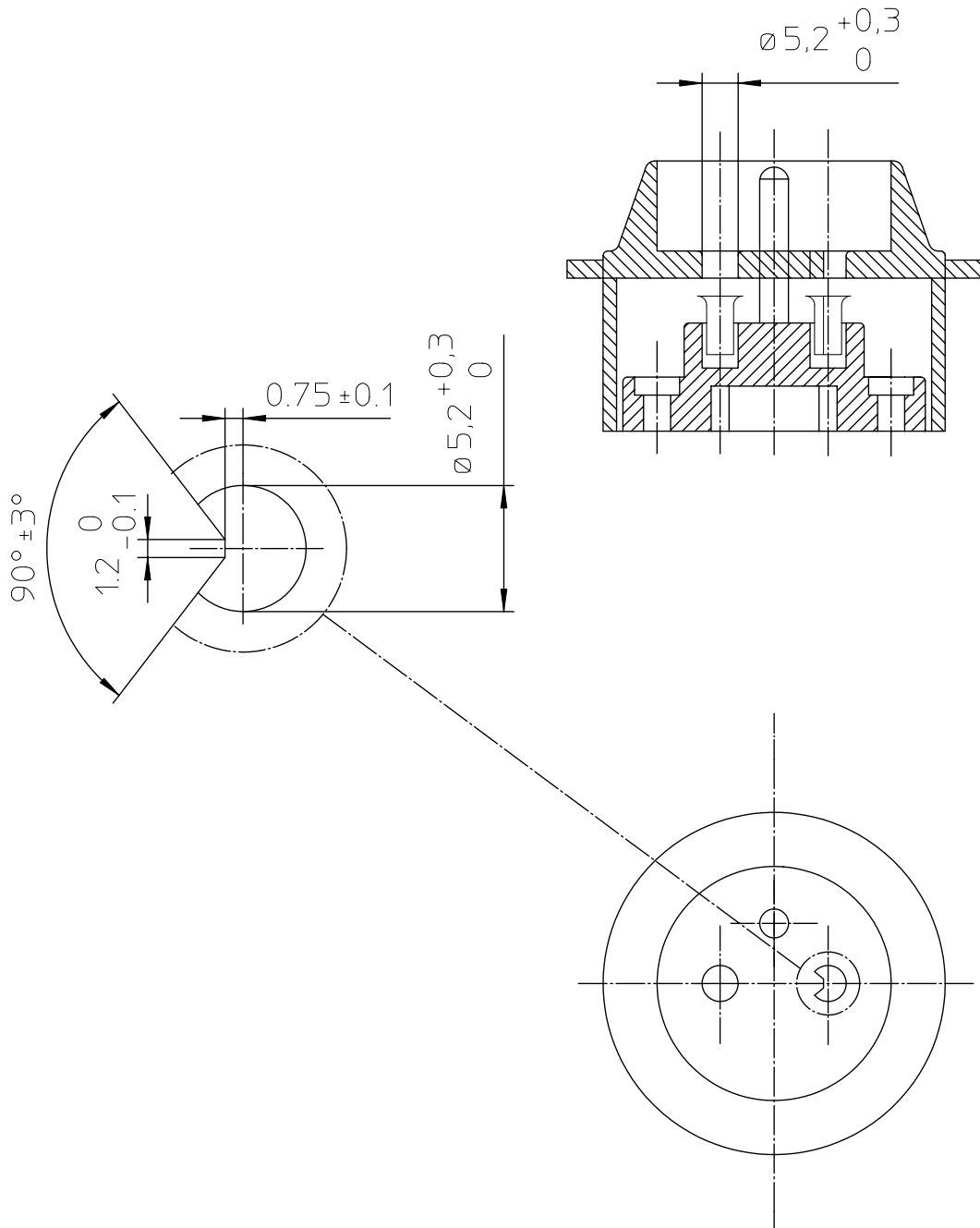
For other dimensions and specifications see standard sheet IV.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

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STANDARD SHEET V b

16A/250V AC
10A/250V DC

Two-pole socket-outlet with pin-type earthing-contact
for power supply of AC/DC equipment



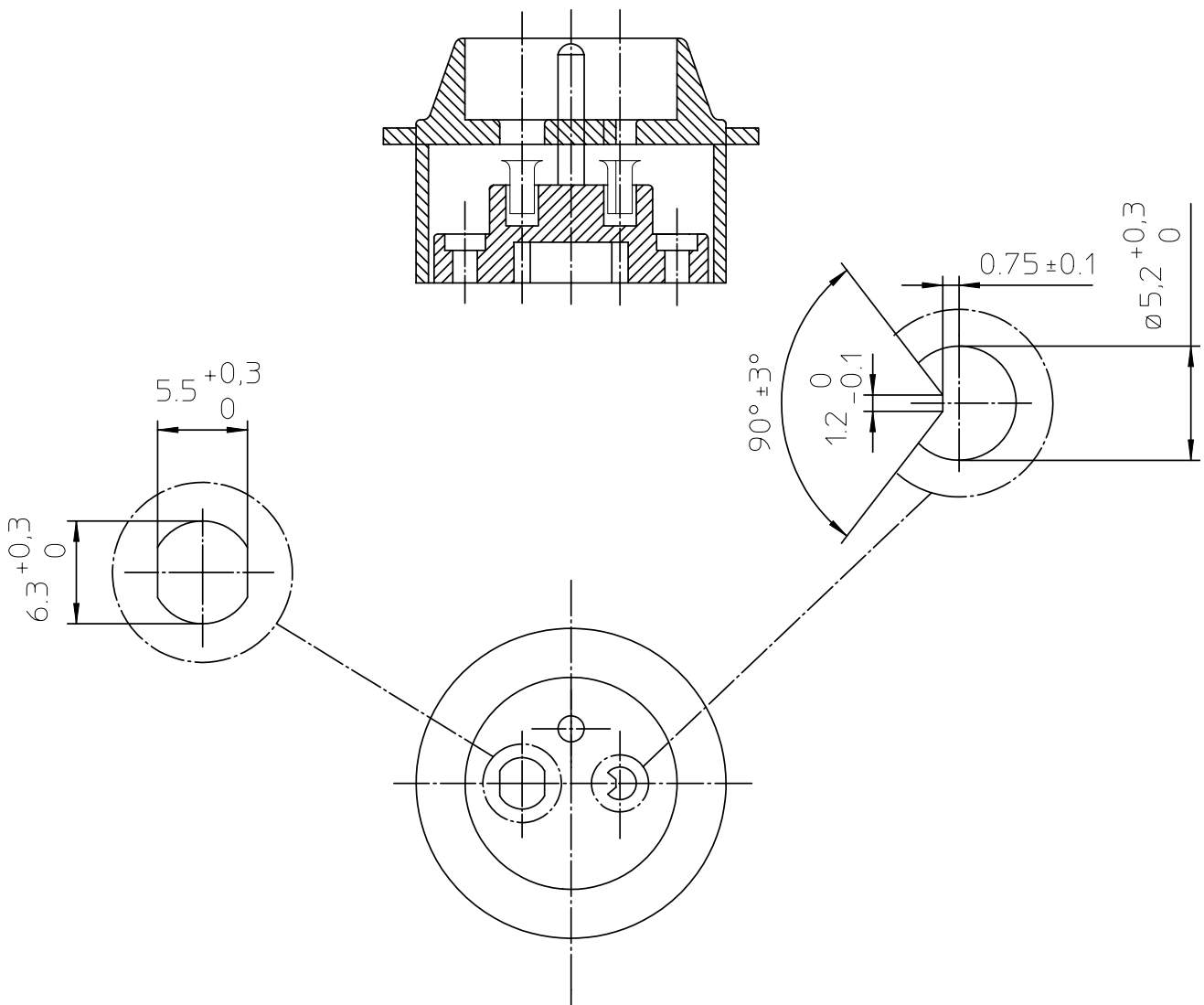
For other dimensions and specifications see standard sheet V.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

DRAFT

STANDARD SHEET V c

10 A/400V DC

Two-pole socket-outlet with pin-type earthing-contact for power supply of DC equipment



For other dimensions and specifications see standard sheet V.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

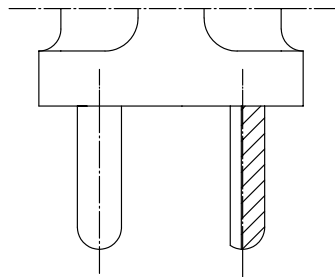
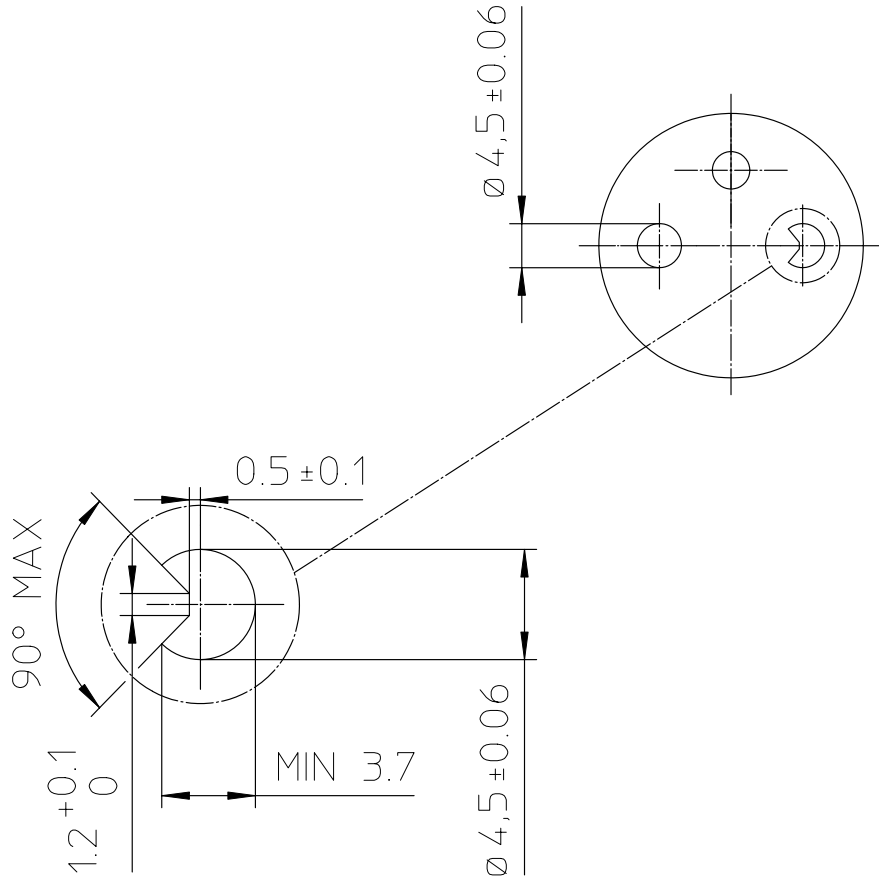
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STANDARD SHEET VI b

16A/250V AC
2,5A/400V DC
without interlock

16A/250V AC
10A/400V DC
with interlock

Two-pole plug with pin-type earthing-contact
for power supply of AC/DC equipment



For other dimensions and specifications see standard sheet VI.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

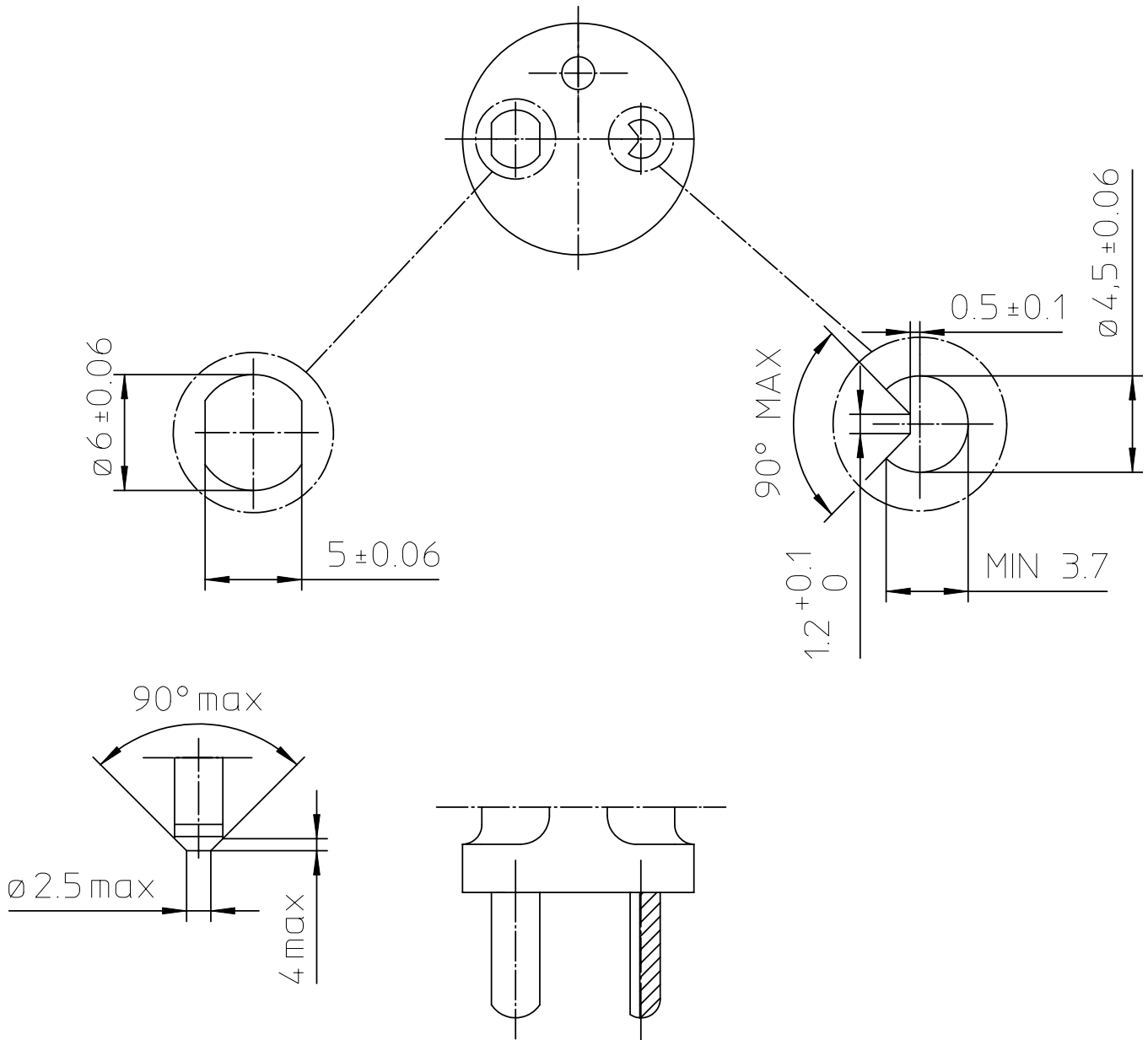
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STANDARD SHEET VI c

2,5A/400V DC
without interlock

10A/400V DC
with interlock

Two-pole plug with pin-type earthing-contact
for power supply of DC equipment



For other dimensions and specifications see standard sheet VI.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

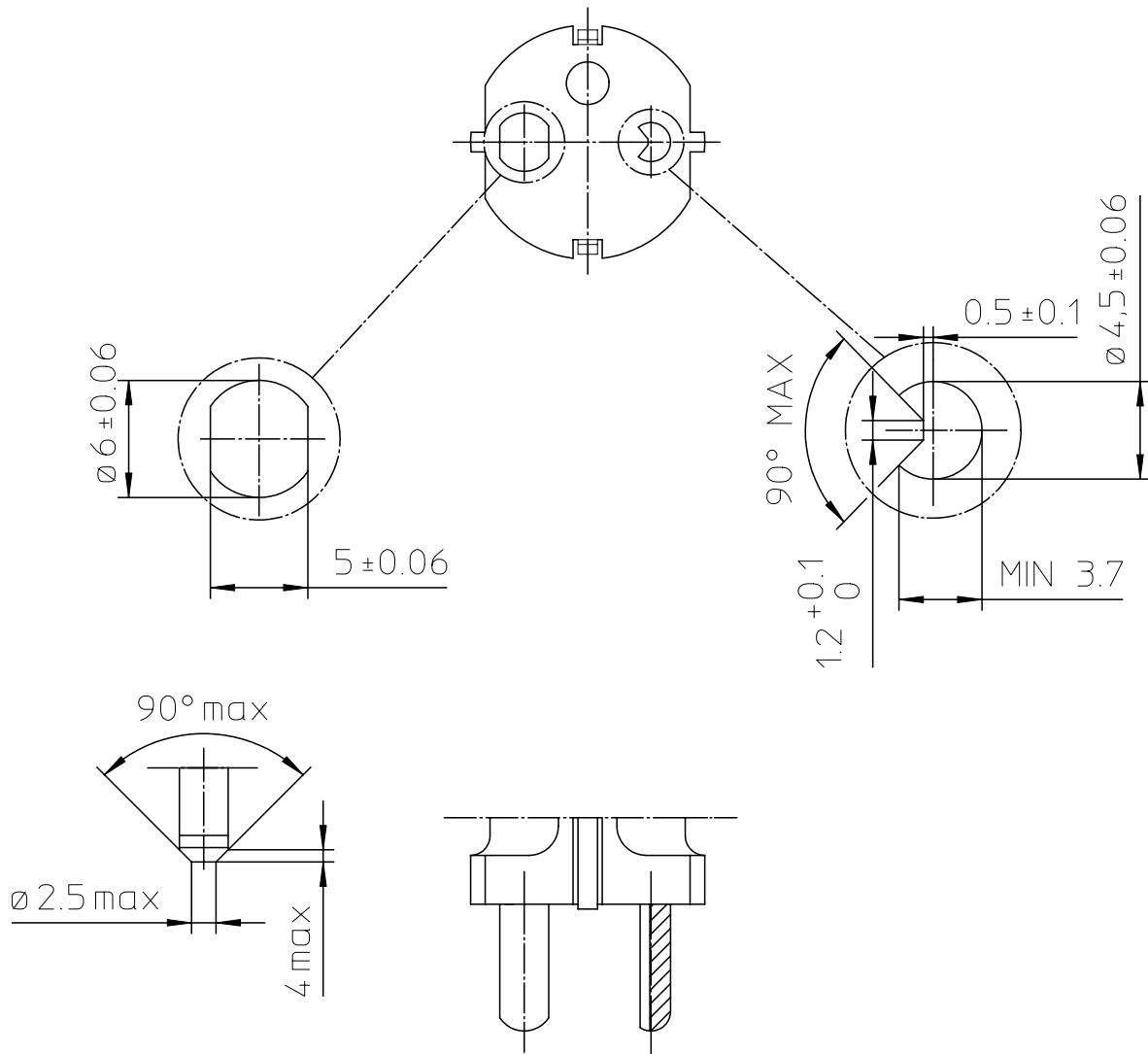
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STANDARD SHEET VII c

2,5A/400V DC
without interlock

10A/400V DC
with interlock

Two-pole plug with dual earthing-contacts
for power supply of DC equipment



For other dimensions and specifications see standard sheet VII.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

Product & Technology



DC Plugs and Socket-outlets

Swedish draft proposal

Merlin Gerin

Square D

Telemecanique

Göran Persson,
2005-08-29

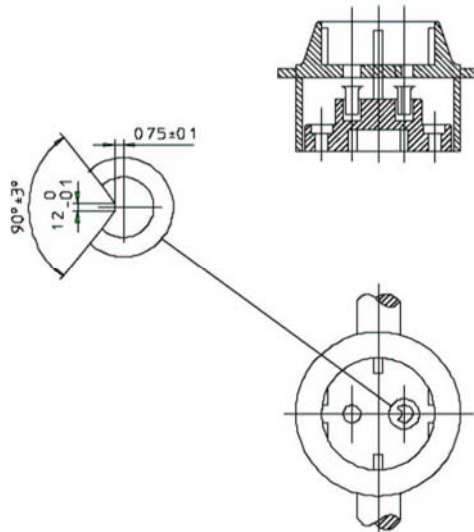


DC Plugs and Socket-outlets

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STANDARD SHEET III b

2,5A / 400 V DC Two-pole socket-outlet with side earthing-contacts for power supply of AC/DC equipment

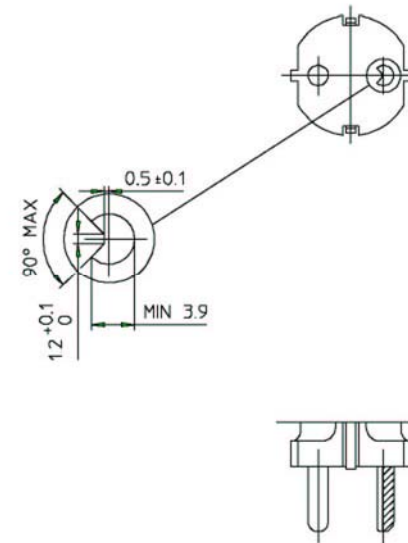


For other dimensions and specifications see standard sheet IV.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

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STANDARD SHEET IV b

2,5A / 400 V DC Two-pole socket-outlet with side earthing-contacts for power supply of AC/DC equipment



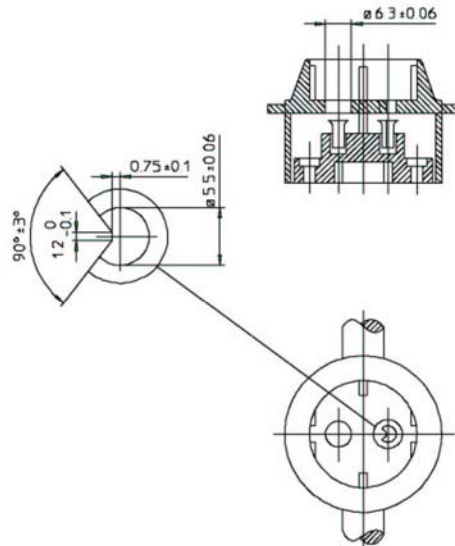
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Dimensions in mm.

DC Plugs and Socket-outlets

DRAFT

STANDARD SHEET III c

2,5A / 400 V DC Two-pole socket-outlet with side earthing-contacts for power supply of DC equipment

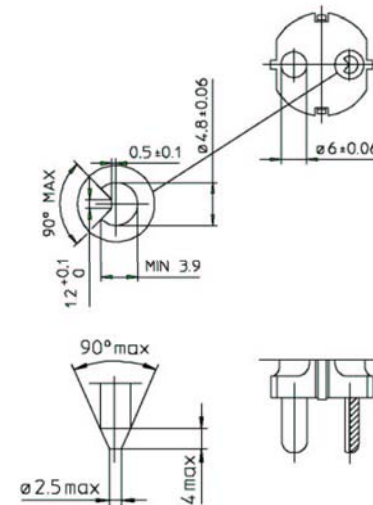


For other dimensions and specifications see standard sheet IV.
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Dimensions in mm.

DRAFT

STANDARD SHEET IV c

2,5A / 400 V DC Two-pole socket-outlet with side earthing-contacts for power supply of DC equipment



For other dimensions and specifications see standard sheet IV.
The sketches are not intended to govern design except as regards the dimensions shown.
Dimensions in mm.

DC Plugs and Socket-outlets

- **IEC 60 884-1 Plugs and socket-outlets for household and similar purposes + national standards**
- **Examples of additions and changes necessary when adding DC**

- **1. Scope**

- Add: This standard does also apply to AC/DC and DC plugs and socket-outlets.
The rated current is limited to 2,5 A for plugs and socket-outlets without interlock.

- **6. Rating**

Add a new row in table 1

Type	Rated voltage V DC	Rated current A DC
2 P plug	400	2,5
2 P		

8.1 Marking

Add.

Socket-outlets according to standard sheet III b shall be marked AC/DC

Socket-outlets according to standard sheet III c shall be marked DC

Plugs according to standard sheet IV b shall be marked AC/DC

Plugs according to standard sheet IV c shall be marked DC

8.2

Add the symbol for direct current

DC Plugs and Socket-outlets

- **IEC 60 884-1 Plugs and socket-outlets for household and similar purposes + national standards.**
- **Examples of additions and changes necessary when adding DC**
 - **8.3 – 8.4**
 - Add: The marking according to the addition in clause 8.1 shall be placed so that it is readable also after the plug inserted in the socket outlet.
 - **9.**
 - Add relevant gauges.
 - **9.101**
 - Add at the end of the requirement: standard sheet III b, III c, IV b and IV c.
 - **15. Interlocked socket-outlets**
 - Socket-outlets for AC and DC might be designed for 16 A current maximum.
 - Plugs for loads for AC and DC rated for up to 2,5 A can be connected and disconnected without interlocking. Plugs for 2,5 A are rated for AC and DC without interlocking mechanical or electronic functions.
 - For loads higher than 2,5 A, the standard AC and DC plug can be used if it is equipped with a mechanical or electronic interlocking switch function with or without connection to the outlets cover. The function shall be designed in such a way that a plug cannot be inserted into or completely withdrawn from the socket-outlet while the plug-contacts can carry current, i.e. the plug-contacts shall be switched off from the load or high-ohmic during these procedures.

DC Plugs and Socket-outlets

- **IEC 60 884-1 Plugs and socket-outlets for household and similar purposes + national standards**
- **Examples of additions and changes necessary when adding DC**
 - **20. Breaking capacity**
 - **21 Normal operation**