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Interconnect adapter for RJ45 interface

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ABSTRACT

Equipment, e.g., backup batteries, within a data center is connected to ethernet cables for the purposes of communication or monitoring. When equipment is installed into or removed from a rack of the data center, the ethernet cable needs to be manually connected or disconnected from its RJ45 socket. The presence of the ethernet cable, connected via RJ45 interface, makes equipment installation or removal a relatively slow, manual process. This disclosure describes two types of adapters - a springboard adapter and a flat-pack adapter - for RJ45 interfaces. The adapters enable automatic making or breaking of the ethernet connection when equipment is installed into or removed from a rack. The adapters enable automated installation or removal of equipment from the rack of a data center.

KEYWORDS

- Data center maintenance
- Maintenance automation
- Robot-based maintenance
- Server rack
- Equipment installation
- Equipment removal
- Cable termination
- Rack upgrade
- RJ45

BACKGROUND

Equipment within a data center is connected to ethernet cables for the purposes of communication or monitoring. For example, backup batteries in server racks have an RJ45 socket on their front faces. Ethernet cables run between the RJ45 socket on the battery and the RJ45 socket on a network switch. To perform a maintenance swap, an operations technician manually disconnects the ethernet cable from the RJ45 socket on the battery side, removes the old battery, and installs a new one. The fact of the ethernet cable connected via RJ45 jack makes the removal and installation procedure unsuitable for automation. Additionally, the presence of ethernet cables in the travel path of the battery hinders automation.

DESCRIPTION

This disclosure describes adapters for the RJ45 interface that enable automatic making or breaking of the ethernet, e.g., data and electrical, connection when equipment is installed into or removed from a rack. The described adapters enable automated, e.g., robot-based, installation or removal of equipment from the rack of a data center. The described adapters fall into two categories: springboard and flat-pack.

Springboard adapter

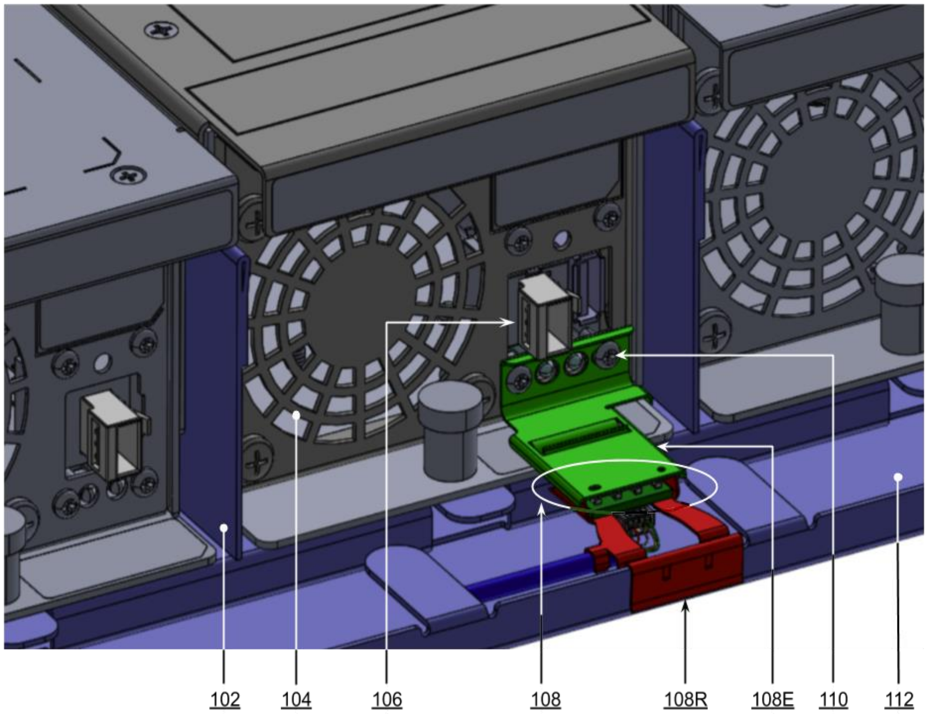
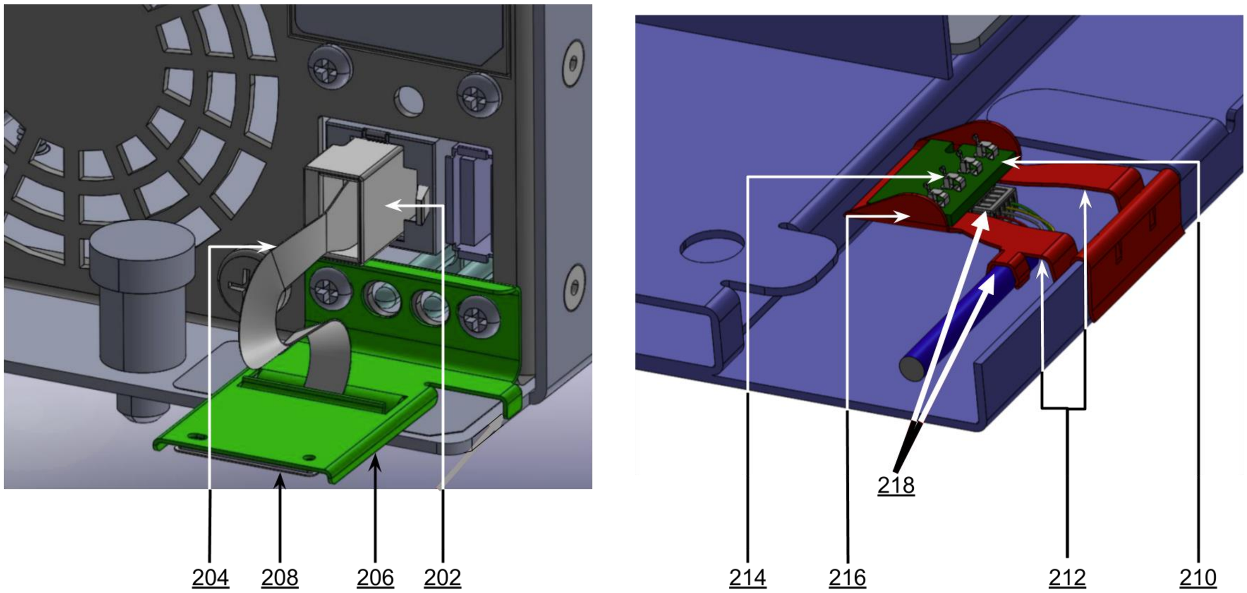


Fig. 1: A springboard RJ45 adapter

Fig. 1 illustrates a springboard RJ45 adapter, per techniques of this disclosure. A piece of equipment (104), e.g., back-up battery, with an RJ45 interface (106) is mounted on a rack (102) with a cable trough (112). The springboard adapter (108) comprises two sections, a (green) L-shaped bracket (108E) attached to the equipment using, e.g., screws (110), and a (red) rack-side section (108R) that clips on to a wall of the cable trough.



(a) (b)

Fig. 2: (a) Equipment section, and (b) rack section of the springboard adapter

Fig. 2 illustrates separately and in greater detail the equipment-side and rack-side sections of the springboard adapter. Fig. 2a illustrates the equipment-side section of the springboard adapter (206), which has on its lower surface an equipment-side PCB (208). Electrical and data lines from the RJ45 plug (202) connect via a cable (204), e.g., a flexible flat cable, to the equipment-side PCB. Each line from the RJ45 plug connects to a unique trace on the equipment-side PCB.

The rack-side section (Fig. 2b) of the springboard adapter includes a rack-side PCB (210), which mates with the equipment-side PCB. On the rack-side PCB are a number of spring-clip connectors (214) that make electrical connections with the traces on the equipment-side PCB. The spring-clip connectors are connected to an ethernet cable (218) that in turn connects to a network switch. The rack-side PCB rests on a surface connected to the trough-wall clip via arms (212) that can flex up and down, e.g., serve as a springboard, similar to a diving board. The sides of the rack-side section have semi-teardrop shaped elements (216) known as ears.

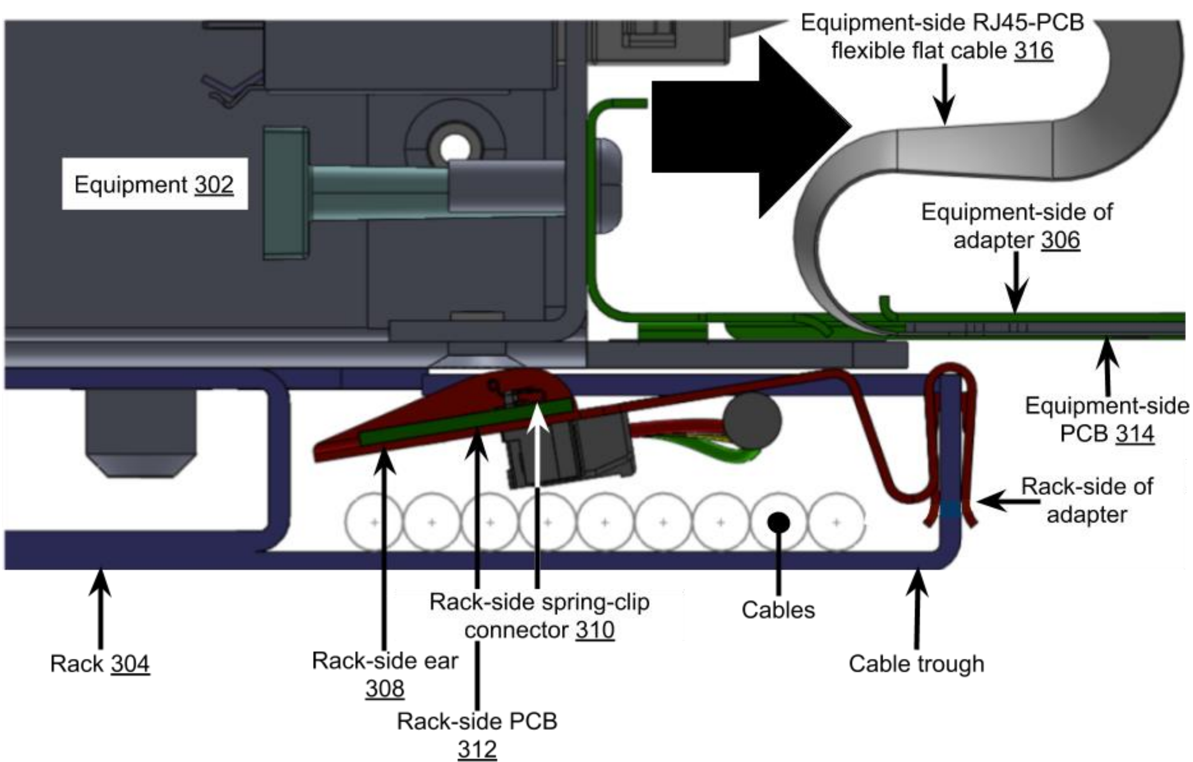


Fig. 3: Pulling out equipment from a rack (side view)

In normal operation, as shown in Fig. 1, ethernet connectivity between the equipment and the network switch is made possible by the electrical contact between the rack-side and equipment-side PCBs. When the equipment is pulled out for maintenance, as shown in side view in Fig. 3, the very act of moving the equipment breaks the ethernet connection smoothly, as follows. Equipment (302), which rests on rack (304), is pulled out. The equipment-side adapter (306) continues to be connected to the RJ45 socket on the equipment via the flexible flat cable (316). By virtue of the teardrop shape of the ear (308) of the rack-side adapter, upon outward movement of the equipment, the rack-side PCB (312) gets lowered by the lower surface of the equipment. The equipment-side PCB (314) and the rack-side PCB break their contact, e.g., the rack-side spring-clip connector (310) loses its connection with the corresponding traces on the equipment-side PCB.

In this manner, a piece of equipment can be removed without manually having to disconnect its ethernet (RJ45) connection; the springboard adapter automatically breaks the ethernet connection upon equipment removal. Similarly, when a piece of equipment is installed, the springboard adapter described herein automatically makes the ethernet connection, obviating the need for manual insertion of an RJ45 plug into the ethernet port of the equipment.

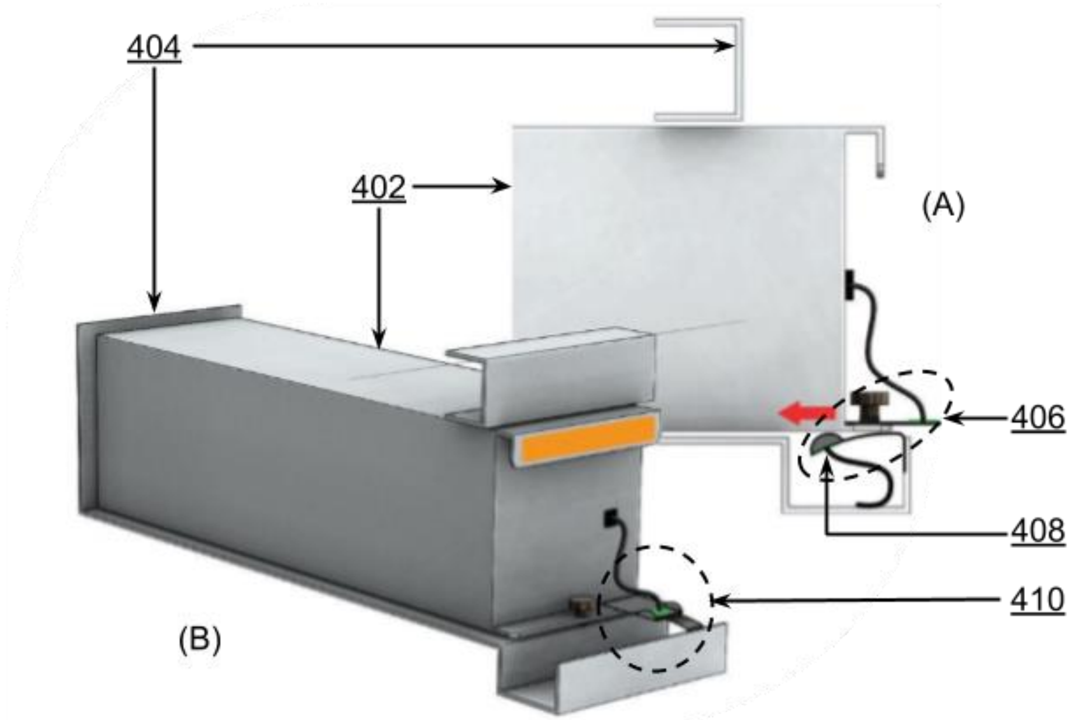


Fig. 4: (A) Side view and (B) perspective view of equipment being inserted into a rack

Fig. 4 illustrates side (Fig. 4A) and perspective (Fig. 4B) views of equipment (402) being inserted into a rack (404). In Fig. 4A, the equipment is just about to enter the rack, such that the springboard adapter (406) has not yet made the electrical connection; the rack-side section (408) is lowered. In Fig. 4B, the equipment is fully inserted into the rack, such that the springboard adapter (410) has made electrical connection and can convey ethernet signals from equipment to network switch. The springboard adapter is retrofittable to existing data center equipment.

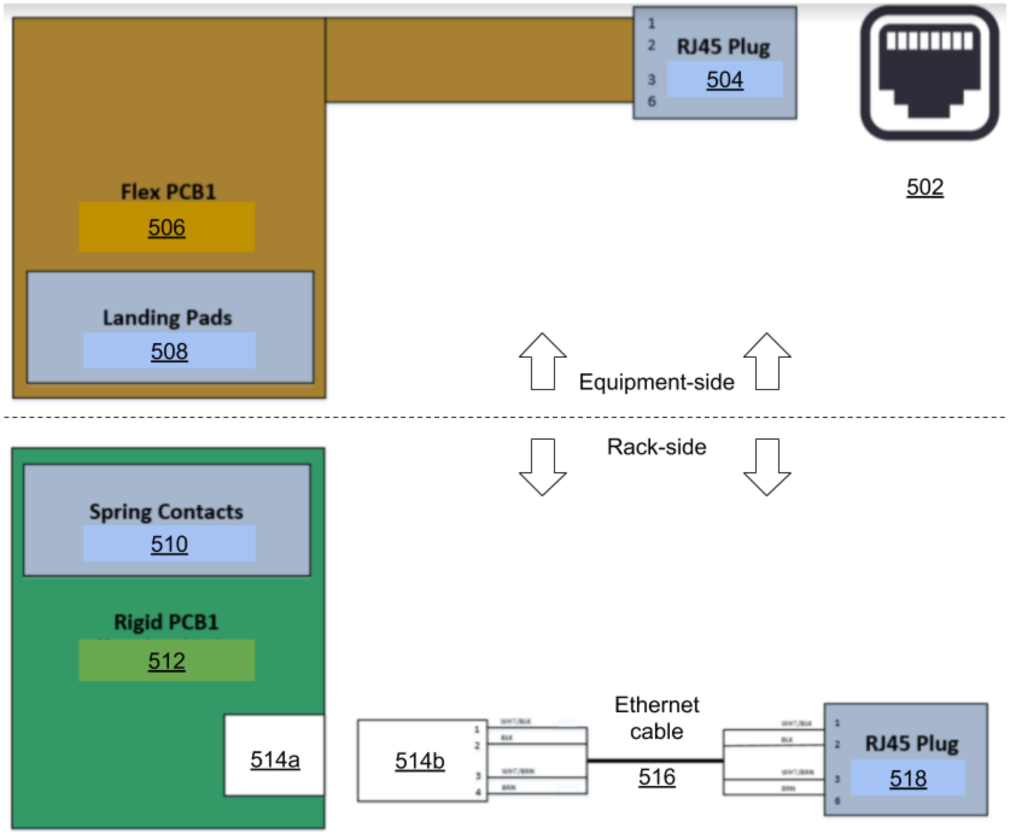


Fig. 5: Electrical schematic of the springboard adapter

Fig. 5 illustrates an electrical schematic for the springboard adapter. On the equipment-side, an RJ45 plug (504) plugs into a socket (502) on the equipment. The RJ45 plug is coupled to landing pads (508) on a flexible PCB (506) via a flexible flat cable. The flexible PCB is mounted on the lower surface of an L-shaped equipment-side bracket. On the rack side, spring contacts (510) on a rigid PCB (512) make or break electrical connectivity with landing pads on the equipment side. The rigid PCB is mounted onto a rack-side bracket. The rigid PCB connects to a cable (516) via connectors (514a-b). The cable connects to an RJ45 plug (518) that connects to a socket on a network switch.

Flat-pack adapter

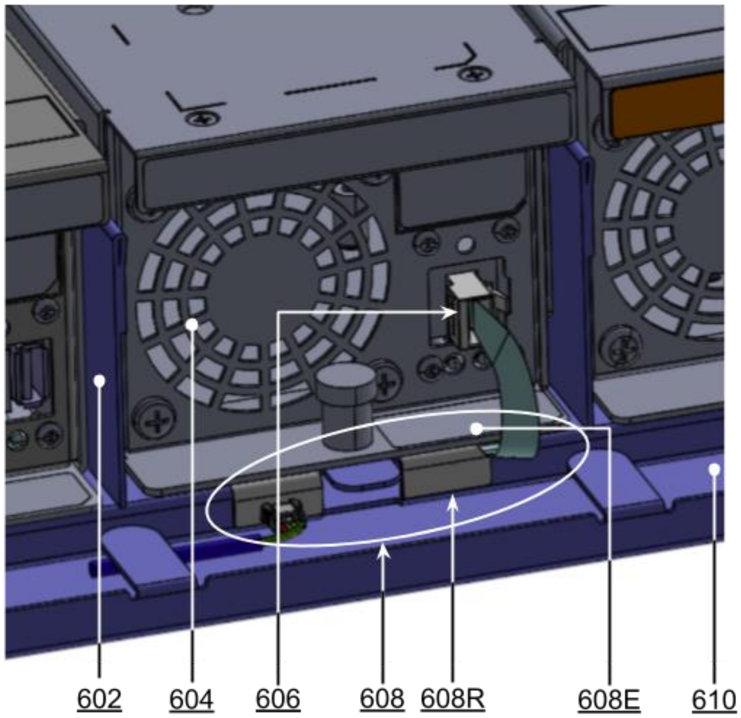


Fig. 6: A flat-pack RJ45 adapter

Fig. 6 illustrates a flat-pack RJ45 adapter, per techniques of this disclosure. A piece of equipment (604), e.g., back-up battery, with an RJ45 interface (606) is mounted on a rack (602) with a cable trough (610). The flat-pack adapter (608) comprises two sections, an equipment-side section (608E), and a rack-side section (608R) that clips to a surface of the rack.

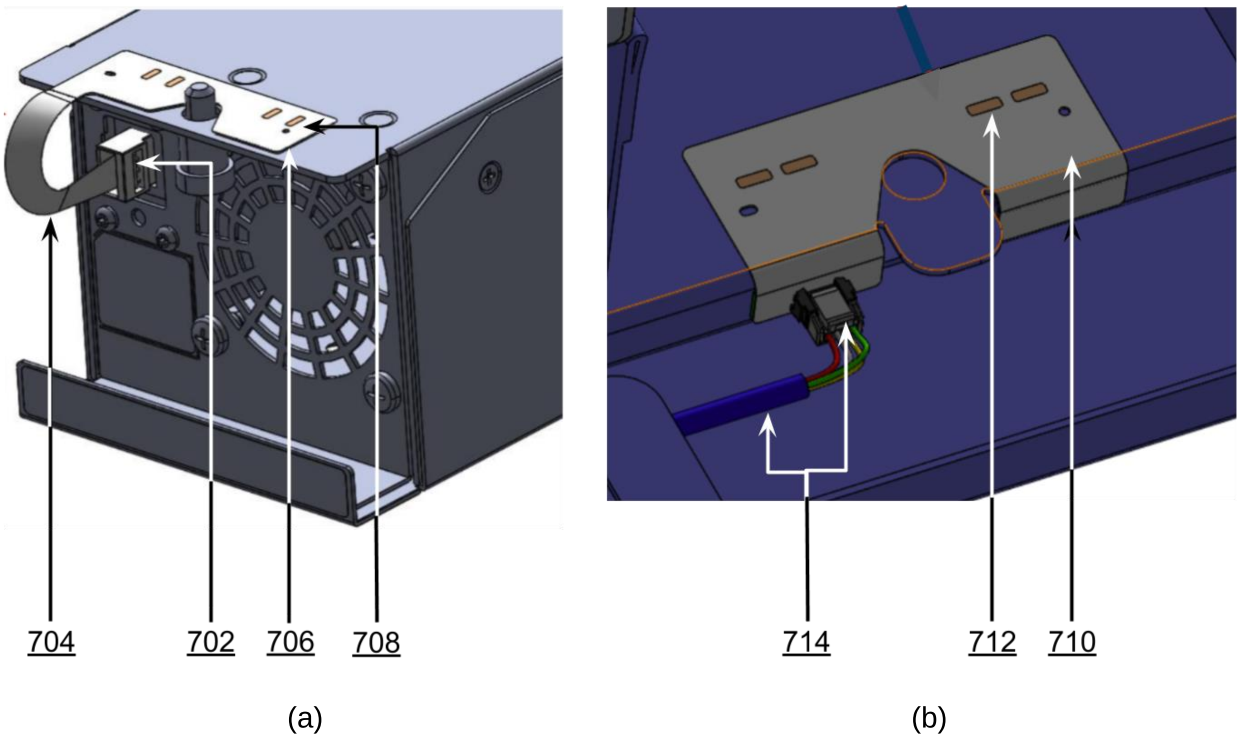


Fig. 7: (a) Equipment section, and (b) rack section of the flat-pack adapter

Fig. 7 illustrates separately and in greater detail the equipment-side and rack-side sections of the flat-pack adapter. The equipment-side section (Fig. 7a) of the flat-pack adapter includes a flexible flat cable (FFC) circuit (706) affixed on the lower surface of the equipment. For clarity, Fig. 7a illustrates the equipment upside down. Electrical and data lines from an RJ45 plug (702) on the equipment connect via a flexible flat cable (704) to the equipment-side FFC circuit. Each line from the RJ45 plug connects to a unique trace on the equipment-side FFC circuit (708).

The rack-side section (Fig. 7b) of the springboard adapter includes a rack-side FFC circuit (710) that mates with the equipment-side FFC circuit. On the rack-side FFC circuit are a number of traces (712) that make electrical connections with the traces on the equipment-side FFC circuit. The rack-size traces are connected to an ethernet cable (714) that in turn connects to a network switch.

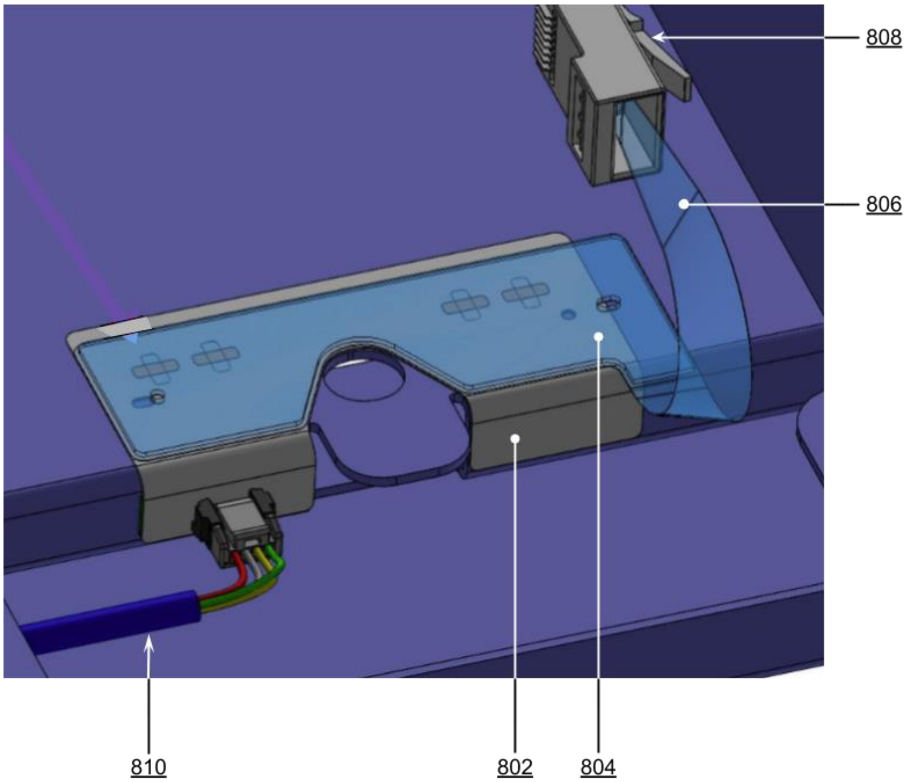


Fig. 8: Close-up of the equipment-side and rack-side sections of the flat-pack adapter mated together

Fig. 8 illustrates a close-up of the equipment-side (804) and the rack-side (802) sections of the flat-pack adapter mated together. For clarity, the equipment is not shown. The equipment-side FFC circuit connects to the RJ45 connector (808) on the equipment via a flexible flat cable (806), while the rack-side FFC circuit connects to an ethernet cable (810) that in turn connects to a network switch. Both the equipment-side and rack-side FFC circuits are wedged into the space between the lower surface of the equipment and the upper surface of the rack, such that gravity causes the two FFC circuits to make electrical contact.

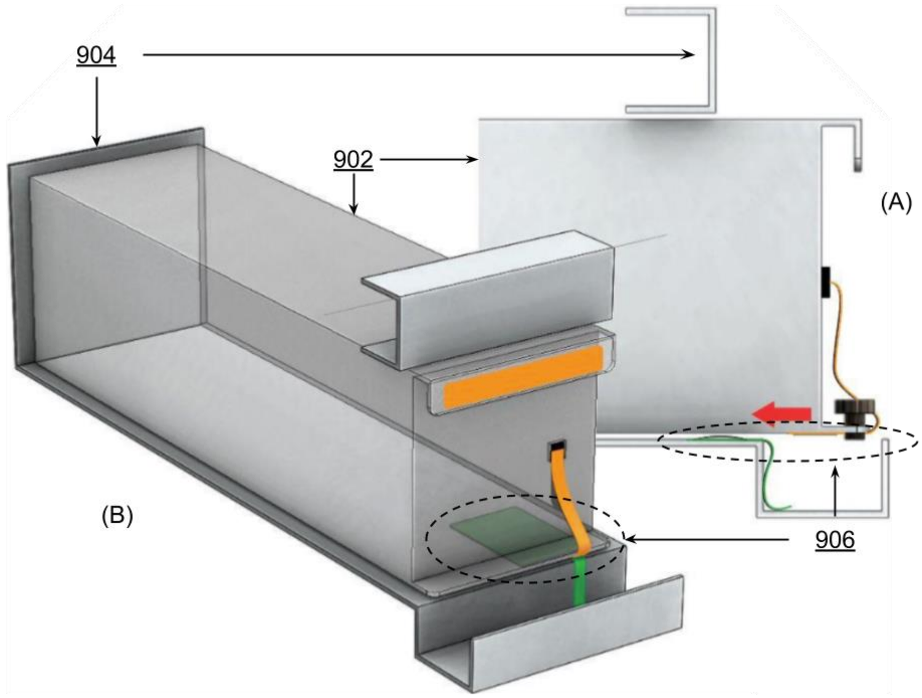


Fig. 9: (A) Side view and (B) perspective view of equipment being inserted into a rack

This is illustrated in Fig. 9, which shows side and perspective views of the flat-pack adapter (906) being wedged in the space between the equipment (902) and the rack (904). In Fig. 9A, the equipment is just about to enter the rack, such that the flat-pack adapter has not yet made electrical connection. In Fig. 9B, the equipment is fully inserted into the rack, such that the flatpack adapter has made electrical connection (906) and can convey ethernet signals from equipment to network switch.

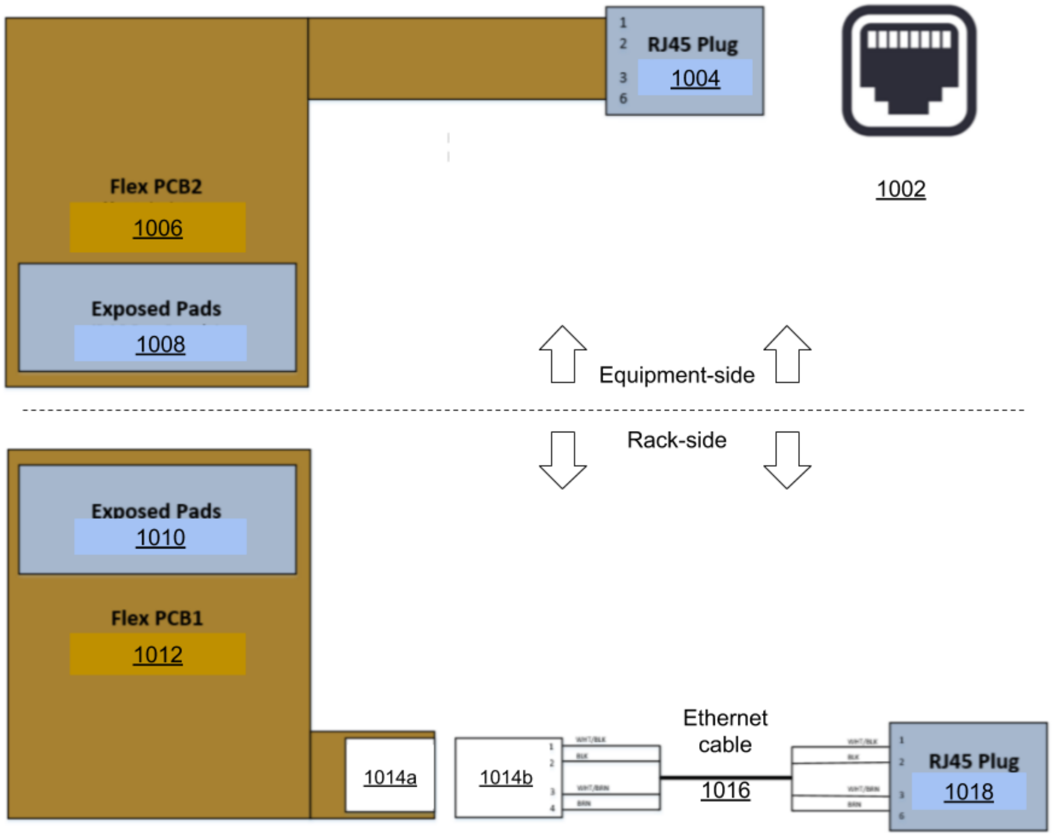


Fig. 10: Electrical schematic of the flat-pack adapter

Fig. 10 illustrates an electrical schematic for the flat-pack adapter. On the equipment-side, an RJ45 plug (1004) plugs into a socket (1002) on the equipment. The RJ45 plug is coupled to exposed pads (1008) on a flexible PCB (1006). On the rack side, exposed pads (1010) on a flexible PCB (1012) make or break electrical connectivity with the exposed pads on the equipment side. The rack-side flexible PCB connects to a cable (1016) via connectors (1014a-b). The cable connects to an RJ45 plug (1018) that connects to a socket on a network switch.

In this manner, a piece of equipment can be removed from a rack without manually having to disconnect its ethernet (RJ45) connection since the flat-pack adapter automatically breaks the ethernet connection upon equipment removal. Similarly, when a piece of equipment is installed, the flat-pack adapter described herein automatically makes the ethernet connection, obviating the manual insertion an RJ45 plug into the ethernet port of the equipment. The flat-pack adapter is retrofittable to existing data center equipment.

The adapters as described herein enable automation of data center part repair and commissioning/decommissioning of server racks. The design can be used for any device that has a RJ45 socket with a traditional ethernet cable connection. For example, when the equipment is a battery, the generalization is to fulfill an automatic connect and disconnect (make-or-break) for electrical data signal by utilizing the motion of battery sliding out of a metal shelf or gravity of battery resting on the shelf instead of requiring either a person or machine to "unplug" a connector-based (RJ45) cable.

CONCLUSION

This disclosure describes two types of adapters, e.g., a springboard adapter and a flat-pack adapter, for RJ45 interfaces. The adapters enable automatic making or breaking of the ethernet connection when equipment is installed into or removed from a rack. The adapters enable automated installation or removal of equipment from the rack of a data center.