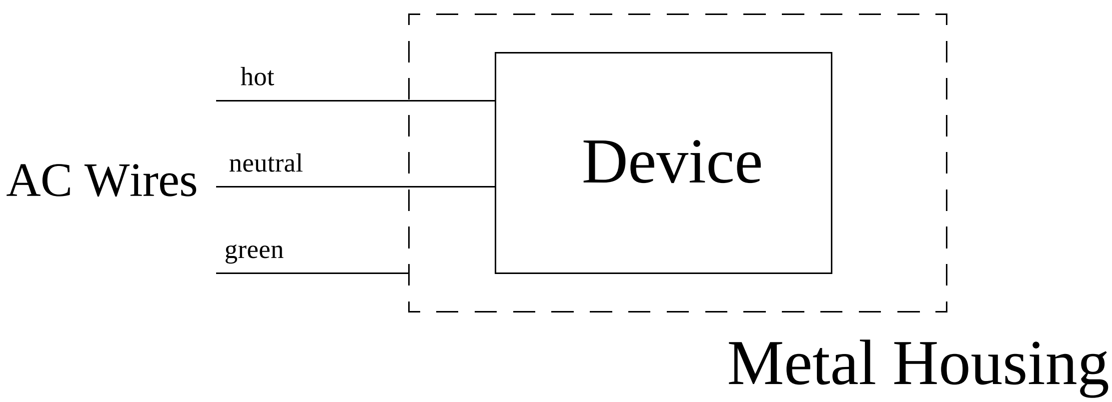
1. Annex A supplement -- electrical isolation (normative)

Electrical isolation is an important system issue discussed in the IEEE Std. 1394-1995 document. However it is desireable to clarify the issues involved and to clearly state that 1394 systems are not required to implement any aspect of electrical isolation. 1394 systems which do not implement electrical isolation may not be compliant with other industrial or medical isolation requirements and users of non-isolated systems may have to deal with grounding problems in their applications.

1.1 Green wire requirements in AC powered devices

Three prong AC plug devices (e.g., PC's, printers, etc.) are electrically wired as:

Figure 1:



Note that the green wire is connected to the exposed metal housing and does not carry power current to or from the powered device. The neutral wire is also connected to earth ground but must carry the full current used by the powered device. Thus neutral wires will exhibit significant voltages due to IR drops across them. Upon an internal short of the hot wire to the metal housing (which would constitute an electrocution hazard to users) large amounts of current will flow through the green wire to ground opening a fuse or circuit breaker in the hot wire circuit. Many consumer electronic products are only powered with two prong AC plugs; however, they have insulated cases to avoid shock hazards.

A consequence of green wire protection is that devices will float their metal housings to the local ground voltage level. Earth grounds can vary by many volts in potential due to nearby equipment returning large currents to earth through their neutral wires, or due to lightning, or due to being in different AC power environments (e.g., between houses the AC power can come from different pole transformers). Makers of electronic equipment often make the reasonable (but not always true!) assumption that all powered devices that can connect with their equipment share exactly the same green wire environment. Makers of medical, telecommunications and industrial equipment must deal with regulations requiring them to limit the chassis to chassis currents that can flow. This is the context that drives electrical or galvanic isolation features.

1.2 Galvanic isolation

IEEE Std. 1394-1995 cables provide three ways in which chassis to chassis ground currents can flow: 1) the ground wire in 6 conductor cables can return ground current to a chassis that has a non-isolated power supply providing cable power, 2) the ground wire in a 6 conductor cable can return ground current to the chassis via the logic circuits of the receiving PHY when the PHY is not electrically isolated from the rest of the logic circuitry in a node (e.g., the LINK), 3) finally the outer shield of a cable must make good electrical connection to all connected chassises to block RF emissions but a DC connection constitutes a direct ground loop -- this is the motivation for using RC circuits between the shield and the chassis to limit power line frequency currents while passing RF frequency currents.

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4 wire A/V cables have their own unique problem of providing a return path to PHY’s for common mode current speed signals through their shields while still blocking power line currents. Thus A/V cables must be either limited to S100 operation (no common mode currents through the shield) or their shield returns have to be carefully managed to provide good RF shielding as well as adequate speed signaling to the PHY, but no power line frequency conductance.

1.3 System impact of galvanic isolation

Galvanic isolation drives a number of 1394 implementation choices: 1) isolated power supplies for PHY’s and cable powering, 2) PHY’s galvanically isolated from LINK’s (which requires separate silicon substrates and capacitive or transformer coupled interface signals), 3) RC coupling from cable shields to chassis frames. All these choices drive up system costs and cause implementation difficulties. In the case of RC coupled cable shields, RF emissions seem excessive and technology circa 1997 does not offer good solutions that are economical and robust against static electricity discharges degrading the isolation capacitors.

For these reasons P1394a removes the galvanic isolation requirement entirely with the consequence that system vendors can provide systems with: 1) cable power supplied from any convenient internal source, 2) PHY’s and LINK’s can be integrated on the same silicon substrate, and 3) all cable shields should be tightly grounded in a 360 degree manner to the chassis bulkhead around the connector.

1.4 Affected sections of the IEEE Std. 1394-1995 standard

The specific sections of the 1995 standard that this annex clarifies or modifies are:

a) Section 4.2.1, “Warning”, p. 55
b) Section 4.2.1.4.8, p. 75
c) Section 4.22.7, p. 81
d) Annex A, p. 243

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