What is the difference between Class I and Class II power supplies?

In this paper, which is intended for electronics engineers and designers working with power systems, David Buck, Product Manager, explains the difference between Class I and Class II power supplies.

References

www.emea.lambda.tdk.com/medical
www.emea.lambda.tdk.com/industrial
www.emea.lambda.tdk.com/cus250m

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David Buck, Product Manager, TDK-Lambda EMEA

AC-DC power supplies for electrical equipment are usually a protection class of Class I or Class II. The term protection class refers to the level of primary to secondary insulation determining whether a product needs to be protectively earthed to avoid an electric shock. Class I power supplies have an earth-ground connection, whereas a Class II product does not.

A Class I product must have two levels of protection between live (primary) parts and the end-user (secondary). If one level of protection fails, the end-user is still safe. User protection is provided by either one or two levels of insulation, either basic or reinforced, and the use of an earth-ground connection from the metal case of the power supply chassis. Figure 1 shows a Class I power supply with a basic level of insulation.

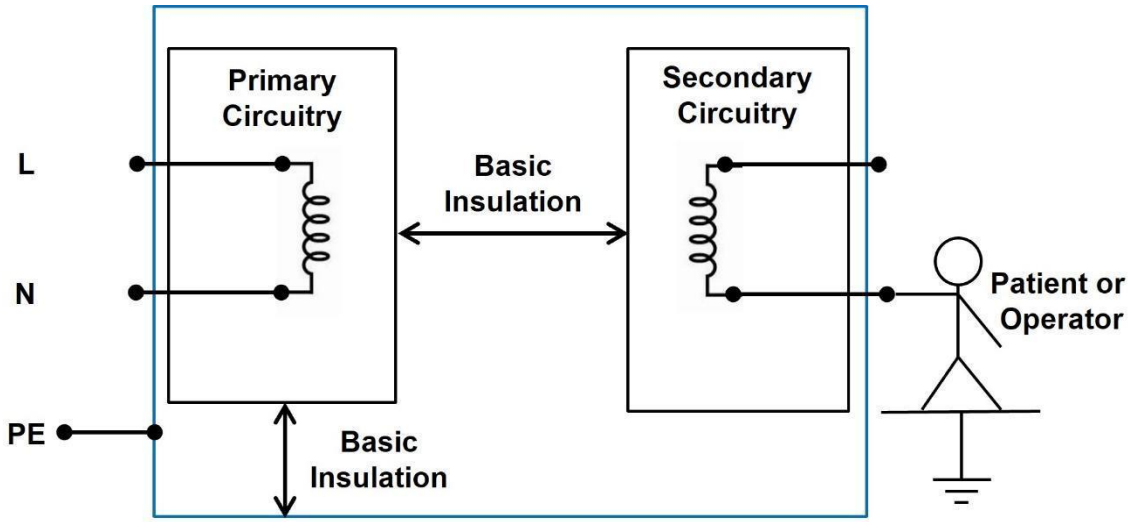

Figure 1: Class I power supply isolation barriers

Suppose the insulation barrier fails between the primary circuitry and the chassis. In that case, the fault current will flow through the primary earth connection and trip the Ground Fault Interrupter (GFI) or the earth leakage breaker. However, estimates indicate that less than half the houses in North America and Europe have reliable earth grounding. A high impedance in the earth connection could lead to an

electrical shock and will have serious implications on a patient whose health could be in a weakened state. Using Class II power supplies avoids this. Therefore, the medical home healthcare standard IEC-60601-1-11 stipulates that Class II equipment must be used.

A Class II power supply typically has an open frame construction or has a plastic case like a laptop power supply or phone charger. Class II products do not need an earth connection. User protection is provided by double or reinforced insulation between the primary and secondary and between the primary and the power supply plastic case or system enclosure, see Figure 2. A single fault would not put the user at risk of electric shock.

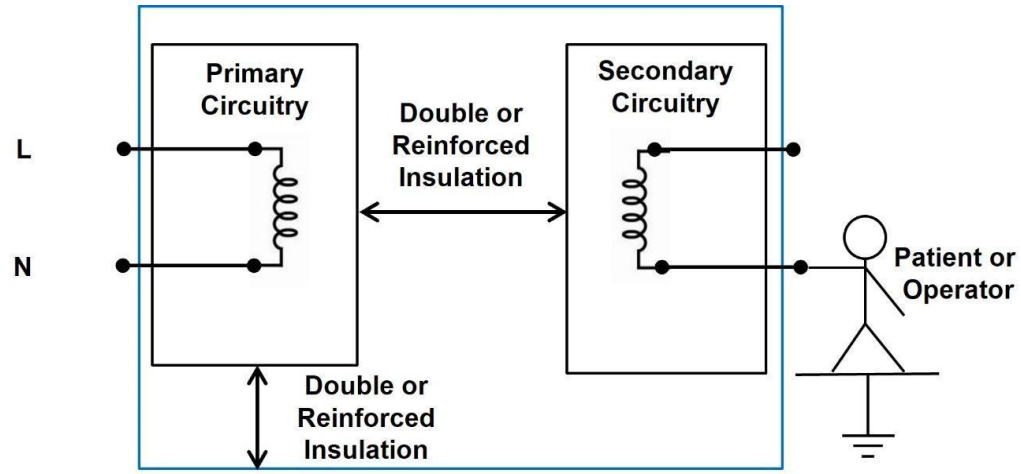

Figure 2: Class II power supply insulation barriers

TDK-Lambda's medically certified open frame CUS250M series (see Figure 3) can be used in either Class I or Class II applications. It has two levels of protection, achieved using double or reinforced insulation.

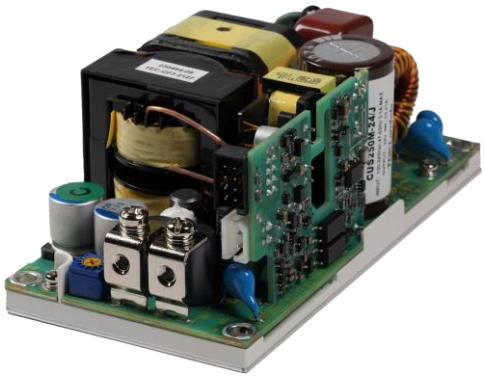

Figure 3: TDK-Lambda CUS250M power supply

The CUS250M also has several enclosure options, including U-channel, cover and fan cooled models.

Figure 4: CUS250M with the U-channel enclosure option

In accordance with the safety standards, the metal enclosure must be earthed as there will not be double or reinforced insulation between the power supply and the chassis. This would make the unit Class I as a fault could make the chassis live and an earth connection is needed to provide a second level of protection.

There is, however, a solution to enable a Class I power supply to be used in a Class II medical device, provided four conditions are met.

1) The power supply must have 1 x MOPP (Means of Patient Protection) from the input to ground (chassis) and 1 x MOPP from the output to ground. The CUS250M does have this (Figure 5).

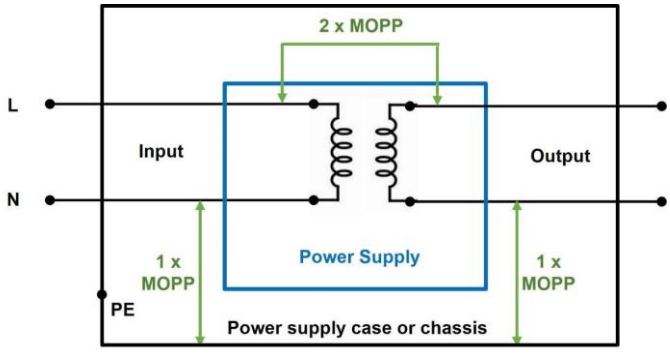

Figure 5: CUS250M MOPP isolation diagram

2) The output touch (enclosure leakage) current must not violate the safety requirements of the end equipment. The CUS250M power supply has a very low touch current of <70µA measured at 264Vac 63Hz, which will be acceptable for most applications.

3) The power supply chassis must have 1 x MOPP isolation from the final equipment enclosure. This can be achieved by mounting the power supply in the end enclosure using non-conductive spacers for insulation, providing a total of 2 x MOPP and double or reinforced insulation between the primary circuit and chassis, see Figure 6.

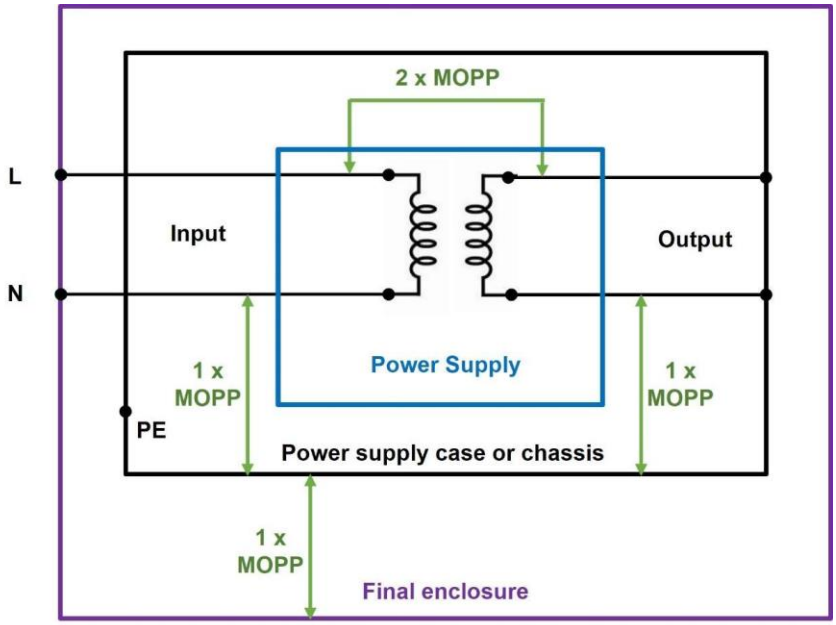

Figure 6: Insulation diagram of power supply in the end (system) enclosure

4) To ensure that the EMC performance is not adversely affected, select a power supply that meets conducted emissions, radiated emissions, and immunity when operated as a Class II power supply. In addition to having a low touch current with 1xMOPP from input to ground and output to ground isolation, the CUS250M has been designed to have EMI margins (Figure 7) greater than 6dB.

Conducted Emissions 240Vac CUS250M-12/J Class I, Full Load

Frequency (MHz)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Quasi-Peak (dBµV)	Limit (dBµV)	Margin (dB)
0.15	43.18	55.88	12.70	59.41	65.88	6.47
0.33	42.58	49.45	6.87	51.33	59.45	8.12
0.33	42.77	49.39	6.62	51.13	59.39	8.26
0.36	39.59	48.64	9.05	51.77	58.64	6.87
0.55	33.01	46.00	12.99	49.76	56.00	**6.24**
0.85	25.48	46.00	20.52	41.96	56.00	14.04
1.10	22.95	46.00	23.05	39.25	56.00	16.75

Figure 7: CUS250M conducted emission levels and margins

The end system will need to be certified to the appropriate EMC standards for the CE and UKCA marks to be applied. Commonly EN 55011 or EN 55032 are used, with the more stringent Class B level for residential applications.

Many engineers have access to internal pre-compliance testing to perform initial checks before final testing at an accredited facility. A 6dB margin is highly recommended to compensate for any internal test inaccuracies. This will avoid expensive retests at the external facility, redesigns and even delays in a product launch if a product fails.

For more information about power supplies from TDK-Lambda, please visit:

www.emea.lambda.tdk.com/medical
www.emea.lambda.tdk.com/industrial
www.emea.lambda.tdk.com/cus250m

You may also contact the author with any questions or comments at:
tlu.powersolutions@tdk.com

TDK-Lambda UK Ltd
Kingsley Avenue
Ilfracombe
Devon EX34 8ES UK
+44 (0)1271 856600
tlu.powersolutions@tdk.com
www.emea.lambda.tdk.com/uk

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