

NEC Class 2 Power Circuits and Power Supplies

Abstract:

The NEC (National Electrical Code) is a North American standard, which can be regarded as a law in most of the North American states. Among others, the NEC describes the installation of electric conductors and equipment within or on buildings.

The NEC also is the source of the Class 2 circuit definition, which limits the max. voltage and current. Such Class 2 circuits have reduced requirements regarding wire size, derating factors, overcurrent protection, insulation, wiring methods and installation materials. Considering Class 2 in a system can be an important factor for reducing the cost and improving the flexibility of the system. Especially when the voltage level of the control circuits is shifted from AC 120V to a DC voltage with 24V, Class 2 could be applicable.

Class 2 requirements for the power sources are also defined in the NEC. Due to the voltage limits of class 2, only the load side of a DC power supply can meet the class 2 circuit requirements.

The following technical note describes the requirements of a Class 2 power supply. Using the SDP4-24-100 as an example, the detailed application and fulfillment of the NEC requirements for Class 2 power sources is portrayed. Furthermore, this report explains why a frequently desired 90W option of the SDP4-24-100 is not necessary according to the NEC requirements. The UL approvals of the standard SDP4-24-100 power supply have now been completed. They explicitly confirm the fulfillment of the NEC requirements, and therefore, Sola/Hevi-Duty sees no necessity for the 90W option.

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1 Introduction:

The NEC (National Electrical Code) is a North American standard, which can be regarded as a law in most North American states. The NEC is developed through a consensus process by the NFPA (National Fire Protection Association). The NFPA 70 document and the NEC are the same. Compared to UL Standards – which covers requirements of devices -, the NEC takes care of electric conductors and installation methods within or on public and private buildings (and structures).

The NEC Code is published in the NEC Code Book, which is released every three years. The current version is the Code Book of the year 2002. All data of this Technical Note corresponds with this version.

The NEC is the source of the Class 2 circuit definition as well as for the Class 2 Power Supply definition. Class 2 defines the portion of the wiring system between the load side of a Class 2 Power Supply (beginning from the outside of a cabinet or machine) and the connected equipment. Due to its power, current and voltage limitations, a class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection against electric shock.

The NEC is not harmonized with other countries. Similar standards exist in Germany (VDE 0100), Canada (CSA C 22.1), Switzerland (SEV HV1000), Great Britain (BS7671) or as international standards (IEC 364...). None of the other countries have any comparable to a Class 2 definition. Class 2 can be regarded as a North American specialty, which is applicable in the USA, in states using American standards or when other countries ship their products to such areas.

Only the load side of a power supply with a nameplate rating of less than 100VA (or 5 times Vout if output voltage is lower than 20V) can meet the class 2 circuit requirements.

Such Class 2 circuits have reduced requirements regarding insulation, wire size, derating factors, overcurrent protection, wiring methods and installation materials. Considering Class 2 in a system can be an important factor for reducing the cost and improving the flexibility of the system. Especially when the voltage level of the control circuits is shifted from AC 120V to a DC voltage with 24V, Class 2 can be applicable resulting in a huge benefit.

A short installation guideline for Class 2 circuits follows:

- Class 2 requires dry indoor use
- Only for non hazardous location areas
- Circuits shall be grounded
- Two or more Class 2 circuits are permitted within the same cable, enclosure or raceway
- Separate Class 2 circuits from other circuits

For details, please refer to the NEC Codebook.



2 Requirements of a Class 2 Power Sources

The many existing, superficial statements coming from questionable sources create a lot of confusion! Please, before you start reading this chapter, forget everything you have heard about Class 2 and read the following information with an open mind.

Therefore, in this Technical Note we will start at the beginning. This is not as difficult and complex as many may think.

The sole criteria for determining whether a Power Source is class 2 or not can be found in the NEC Article 725-41a):

III. Class 2 and Class 3 Circuits

725.41 Power Sources for Class 2 and Class 3 Circuits.

(A) Power Source. The power source for a Class 2 or a Class 3 circuit shall be as specified in 725.41(A)(1), (2), (3), (4), or (5):

FPN No. 1: Figure 725.41 illustrates the relationships between Class 2 or Class 3 power sources, their supply, and the Class 2 or Class 3 circuits.

FPN No. 2: Tables 11(A) and 11(B) in Chapter 9 provide the requirements for listed Class 2 and Class 3 power sources.

- (1) A listed Class 2 or Class 3 transformer
- (2) A listed Class 2 or Class 3 power supply
- (3) Other listed equipment marked to identify the Class 2 or Class 3 power source

Exception: Thermocouples shall not require listing as a Class 2 power source.

FPN: Examples of other listed equipment are as follows:

- (1) A circuit card listed for use as a Class 2 or Class 3 power source where used as part of a listed assembly
- (2) A current-limiting impedance, listed for the purpose, or part of a listed product, used in conjunction with a non-power-limited transformer or a stored energy source, for example, storage battery, to limit the output current
- (3) A thermocouple
- (4) Listed information technology (computer) equipment limited power circuits.

FPN: One way to determine applicable requirements for listing of information technology (computer) equipment is to refer to UL 1950-1995, Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment. Typically such circuits are used to interconnect information technology equipment for the purpose of exchanging information (data).

(5) A dry cell battery shall be considered an inherently limited Class 2 power source, provided the voltage is 30 volts or less and the capacity is equal to or less than that available from series connected No. 6 carbon zinc cells

Here, you find five options (1. to 5.).

Option 1 is applicable to transformers only; **Option 3** is important for equipment builders, who benefit from a Class 2 power source; and **Option 5** applies only to batteries. These three options do not apply to a Sola/Hevi-Duty power supply.

Option 4 refers to the UL1950 chapter 2.5 "limited power circuits". The fulfillment of this requirement is one way to achieve a NEC Class 2 listing. "Limited power circuit" means, that even in a single failure condition, the output power is limited to 5xVout (Vout ? 5V) or 100VA. This is much tougher than NEC requires and results in power supplies that have a nameplate rating of only 90W or less. This margin in power is necessary for the additional protection circuit to always stay below the 100W in case of a single failure. Sola/Hevi-Duty usually tests safety issues according to this UL 1950 (UL 60950) standard and for power supplies having a rated output power of up to 60W, this option is useful because it is included in the



standard UL 1950 (UL 60950) test procedure. For power supplies with a rated output power (nameplate rating) between 60 and 100W, it is not useful, because a very precise and costly protection circuitry is required. In such cases it is better to use Option 2.

Option 2 calls for a listed Class 2 power supply. This means that you have to apply table 11(a) and 11(b) in chapter 9 of NEC. Table 11(a) covers devices with AC output (class 2 transformers), 11(b) covers power supplies with DC output. Sola/Hevi-Duty only has DC power supplies, not Class 2 transformers, therefore only table 11(b) will be further considered.

Table	11/6)	Close 2 and	Close 3	Direct-Current	Down Conver	Limitatione
i anie	I I I I I I I I I I	. Class Z and	Class 5	Direct-Current	Power Source	2 I JIMITATIONS

		Inherently Limited Power Source (Overcurrent Protection Not Required)				Not Inherently Limited Power Source (Overcurrent Protection Required)				
Power Source		Class 2			Class 3	Class 2		Class 3		
Source voltage V _{max} (volts) (see Note 1)		0 through 20*	Over 20 and through 30*	Over 30 and through 60 *	Over 60 and through 150	Over 60 and through 100	0 through 20 *	Over 20 and through 60 *	Over 60 and through 100	Over 100 and through 150
Power limitations VA _{max} (volt-amperes) (see Note 1)		_	_	_	_	_	250 (see Note 3)	250	250	N.A.
Current limitations I max (amperes) (see Note 1)		8.0	8.0	150/V _{max}	0.005	150/V _{max}	1000/V _{max}	1000/V _{max}	1000/V _{max}	1.0
Maximum overcurrent protection (amperes)		_	_	_	_	_	5.0	100/V _{max}	100/V _{max}	1.0
Power source maximum	VA (Volt- Amperes)	5.0 x V _{max}	100		0.005 x V _{max}	100	5.0 x V _{max}	100	100	100
nameplate rating	Current (Amperes)	5.0	100/V _{max}	100/V _{max}	0.005	100/V _{max}	5.0	100/V _{max}	100/V _{max}	100/V _{max}

Some comments to understand the table:

Class 2 versus Class 3:

Class 2 considers safety from a fire initiation standpoint and provides acceptable protection from electric shock.

Class 3 considers safety only from a fire initiation standpoint. The output voltage can reach values up to 100Vdc on a 100VA power level, which is not typical for Sola/Hevi-Duty power supplies.

Inherently Limited versus Not Inherently Limited Power Source:

<u>Inherently limited</u> means that the power source itself limits the output current (e.g.: using a electronic or magnetic circuitry). All Sola/Hevi-Duty power supplies are inherently limited.

<u>Not inherently limited</u> means that an additional protection device (usually a mechanical circuit breaker or fuse) protects against overload within a defined time. The additional protection device must be installed within or closely connected to the power source, so that it can be regarded as one unit.

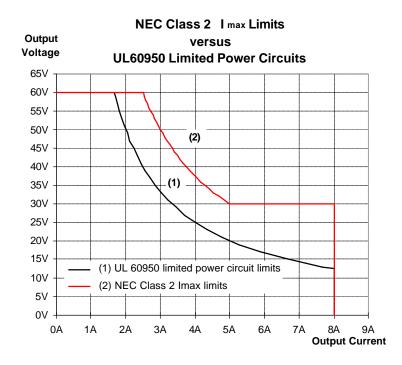
The maximum power source nameplate rating for a Class 2 power supply is 100W (or 5 times Vout if the output voltage is in the range from 0 to 20Vdc). Similar requirements exist for the maximum nameplate



rating of the output current: 5A for output voltages up to 20Vdc or 100 divided by Vout for voltages above 20Vdc.

In case of a single failure of the voltage regulator or current limitation circuitry inside the power supply, the max. output current values according to I_{max} from table 11b apply. The output current at any load must be smaller than I_{max} .

Option 2 (listed Class 2 power supply) is easier to achieve than option 4 (limited power circuit acc. UL 1950). The following graph shows a comparison of NEC Class 2 I_{max} limits with UL 60950 limited power circuit requirements:



The UL 60950 limits are taken directly from the table 2B of UL 1950 or are calculated from the max apparent power divided by the voltage of this table.

3 Other Definitions with a Tendency to Confuse

UL 508 chapter 32.7 "Limited energy circuits":

Has nothing to do with NEC Class 2. Requirement on power sources are less strict compared to the NEC. Volt-ampere capacity is limited to 200VA; voltage is limited to 100Vac.

UL 60950 (UL 1950) or IEC 60950 chapter 2.5 "Limited power source"

Can be one option to achieve NEC Class 2. The requirements are tougher than NEC. The output power is limited to 5xVout (for outputs less than 20Vdc) or 100VA, even in case of failure of the voltage or current regulator or any other single component.



UL 1310 Class 2 Power Units

UL 1310 is the governing standard for Class 2.

These products provide Class 2 power levels in accordance with the NEC and apply to direct plug-in power units and cord-connected power units. A typical Sola/Hevi-Duty power supply for industrial purposes is not covered by this standard.

UL 3101 (EN 61010) Electrical Equipment for Laboratory Use

Annex F defines limited power circuits. The requirements are similar to the NEC, but the nameplate rating is not limited to 100VA (can go up to 150VA). Not an option for NEC Class 2.

UL 1585 Class 2 and Class 3 Transformer

Conforms to the NEC and can be used as an option. But a DC power supply can not be considered as a transformer.

Class II protection of electric shock (in German: Schutzklasse II)

Is not subject to any limited power characteristic. It defines, that all touchable parts of equipment are isolated by double or reinforced insulation.

Class I Div 2

Is not subject to any limited power characteristic. It is a definition in the standard for safety for electrical equipment for use in hazardous (classified) locations

Pollution degree class 2

Environmental condition

Overvoltage Category II

Describes transients on the input mains

4 NEC Class 2 Testing of the Sola Power Supply SDP4-24-100

Frequently a 90W Class 2 option of the 100W SDP4-24-100 unit has been requested. A close study of the NEC Class 2 requirements revealed, that there is no necessity for a 90W model. During the UL certification procedure, the standard SDP4-24-100 has been tested according to the NEC Class 2 and fulfills the requirements. The UL report states:

"Unit does not fulfill requirements of UL 60950 for Limited Power Source.

Unit meets requirements of NEC Class 2 power source".

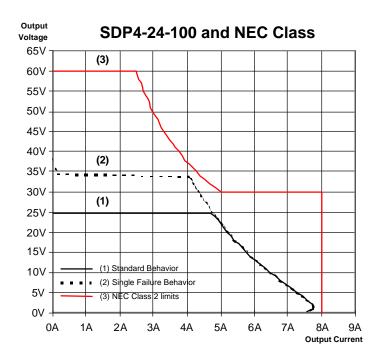
Therefore you can regard the SDP4-24-100 as a listed Class 2 power supply. On the rating label of the unit, we will add the following text: "NEC Class 2 Power Supply".



Benefits of reducing it to one model are:

- Reduced stock keeping
- Full 100W available
- No additional costs
- All other features, such as adjustable output voltage, single / parallel mode are available

The following graph shows the measurement results of the NEC Class 2 testing:



Curve (1) shows the standard load behavior of the SDP4-24-100 set to 24.5V output voltage. In the range from 0A to 4.6A, the output voltage regulator stabilizes the output voltage. Above this range, the current limitation circuitry limits the output current.

Curve (2) shows the behavior when the output voltage regulator fails. The output voltage increases to approx 34.5V and is regulated to this value by a redundant voltage regulator. This redundant voltage regulator works with a "hiccup mode," which means, that the voltage stays at that level only for a short period of time before it shuts down. Automatic start-up attempts follow.

In case of a failure of the current limitation circuitry, the input fuse will blow and the output will go to zero. Curve (3) shows the limits of the NEC Class 2.

The above curves were tested at different input voltages and temperatures.

As long as the additional fulfillment of the "Limited Power Circuit" of EN60950 is not demanded, we will not launch a separate 90W model (SDP4-24-100A) as previously planned.





Technical Service

While every precaution has been taken to ensure accuracy and completeness in this manual, Sola/Hevi-Duty assumes no responsibility, and disclaims all liability for damages resulting from use of this information or for any errors or omissions.

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