

# Safety aspects of users operating with HDD external USB case

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**Abstract - Random survey on few HDD external cases with USB connector shows that even simple data backup can be hazardous to the operator. Measurements on external cases for HDD products of different manufacturers shows that some of them have problems with power supplies. Tested external cases are in operating state and function properly, but on USB shield and aluminium case on some of them 86 V to 109 V AC is measured. Although the leakage current is rather small, this does not comply with safety regulations and could induce small electrical shock for operator.**

## I. INTRODUCTION

During one regular backup using external HDD (hard disc drive) one of the authors of this paper has experienced electrical shock. First thought was static electricity, but another electrical shock that followed soon after the first gave reason to check the voltages by measurement [2]. When measurements showed unallowable values of AC the device was exchanged with another. Surprisingly, every other external HDD of the same manufacturer also had unallowable values of alternating voltage, although all devices were functional, and the values of DC were within range specified on product declaration. This experience led authors to detail research on external HDD correctness [3]. Research included different types and manufacturers of external HDD [4], [5].

## II. POWER SWITCHING SUPPLY MODEL AND VOLTAGE MEASUREMENT

Construction of external HDD for 3 1/2-inch disk drives that are treated in this paper consists of switching power supply, HDD in separate case, USB cable and USB connector that is connected to a PC, as shown in Fig. 1.

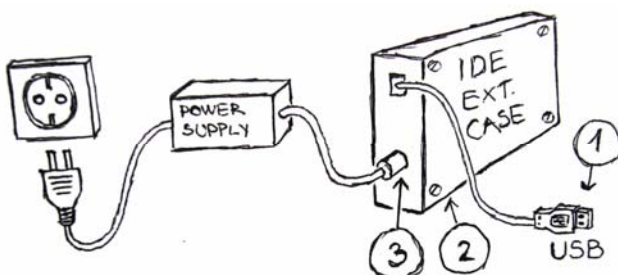


Fig. 1. External HDD parts.

Some manufacturers have switcher integrated in the same HDD case. Construction of mains connector may also

vary, but most give voltages 5 V or 12 V required for motor startup and HDD electronics supply, Fig. 2, [3]. All tested power supplies have CE certificate.

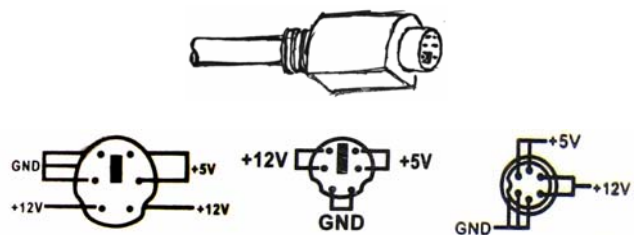


Fig. 2. Mains specification for some manufacturers.

First measurements were conducted using digital voltmeter. Voltmeter was adjusted according to the specified values on the external HDD declaration. Measurement confirmed values of +12 V and +5 V DC, as expected. When alternating values was measured, the instrument showed surprisingly 84 V AC.

Power switching supply model which is usually used is shown in Fig. 3, and it's typical waveforms are depicted in Fig. 4, [1].

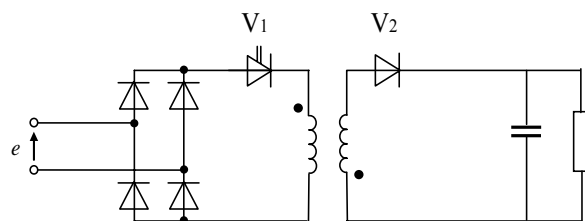


Fig. 3. Power switching supply model.

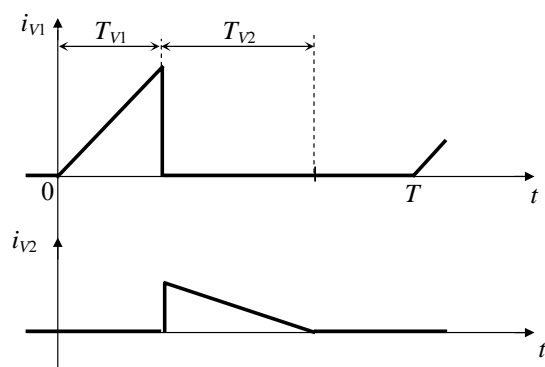


Fig. 4. Typical waveforms of power switching supply.

Due to the flyback converter model which is used as power switching supply and its characteristics (Fig. 3 and Fig. 4) is decided to perform measurements using digital oscilloscope to see voltage waveforms and to investigate possible cause, [2]. Fig. 5, Fig. 6 and Fig. 7 give voltage waveforms in measuring points 1, 2 and 3 in Fig. 1.

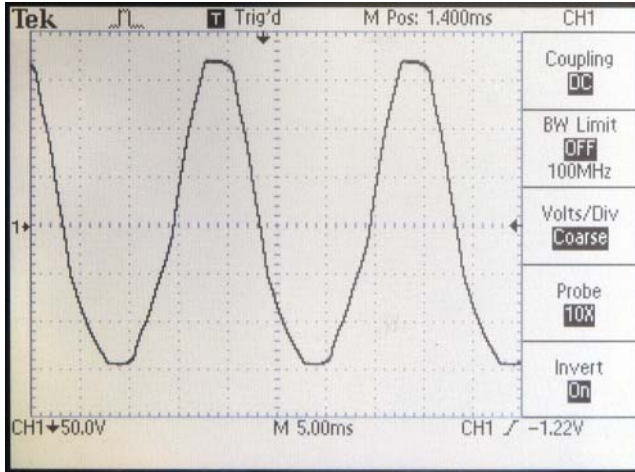


Fig. 5. Voltage at measuring point: Mains-to-Ground.

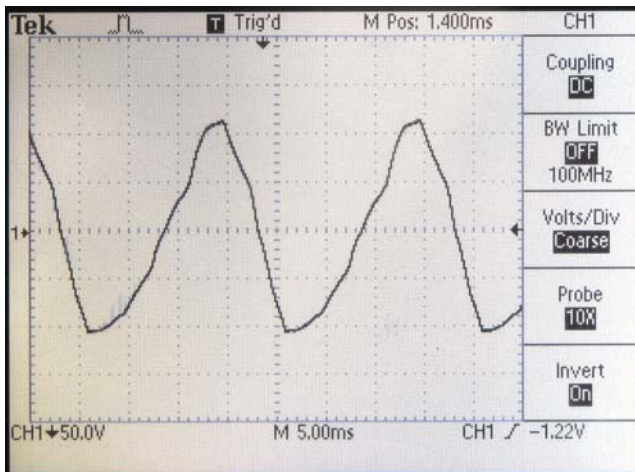


Fig. 6. Voltage at measuring point: Case-to-Ground.

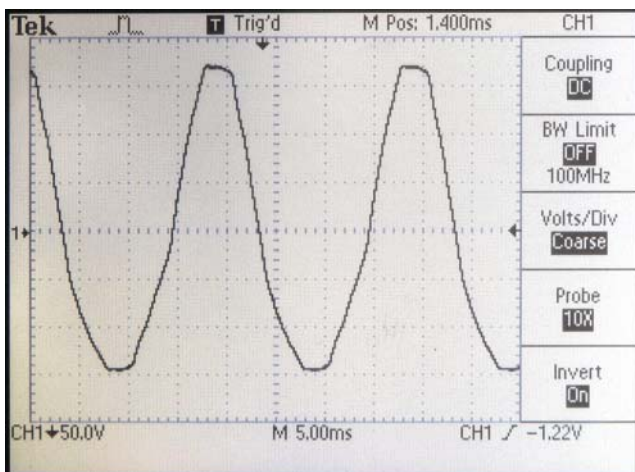


Fig. 7. Voltage at measuring point: USB connector-to-Ground.

Scopes show somewhat distorted sine waves which leads to assumption that voltage is transferred from power grid (outlet) over flyback converter capacitive impedance.

Nevertheless, many different devices from different manufacturers from different price ranges are gathered. All showed existence of alternating voltage component, although all functioned properly when used for backuping data to external HDD. Table 1 shows name of the model and average values of AC voltages from repeated measurements at measuring points 1, 2 and 3 from Fig 1. Zero voltage Case-to-ground at some models in table 1 indicates that these models have plastic cases.

TABLE I  
EXTERNAL HDD MODELS

Model	Number of units tested	Measured AC voltage, V		
		Mains	Case	USB connector
ICY BOX	3	111,6	111,6	111,6
ORMEL	2	84,75	84,75	84,75
Evertch	1	120,6	120,6	120,6
Bona	1	92,6	0	92,6
Matrix	1	87,47	48,31	87,47
NexStar2	1	106,4	0	106,4

### III. SAFETY REGULATIONS AND EFFECTS ON HUMAN BODY

#### A. Regulations

External HDD is a device for everyday use and should comply with safety regulations. By visual inspection on USB connector no computer user expects voltages higher than proscribed. This paper came out as a result of taking computer equipment safety for granted. High AC voltage is detected on places where it should not be, and moreover its' values are in conflict with IEC standards [4] and [5] thus represent safety risk to the user. According to the publication IEC 479-1/84 recommended upper limit for touch voltage for humans is 50 V at 50-60 Hz. In this paper voltages are measured without load on USB connector. When connected to metal grounded computer case a current of ~0.2 mA runs through the closed circuit and voltage returns back to normal. This confirms the fact that manipulation with external HDD, when connected to the power supply, represents safety risk to the user, specially in case of lowered resistance i.e. sweaty hands, etc.

#### B. Effects on human body

Curve II in Fig. 8. shows lower current sensitivity level dependence on frequency [7]. It can be seen that at 50 Hz frequency man can sense current greater than ~0.3 mA. In

previously conducted experiment it is most likely that initial current was greater than 0.3 mA, and after a while has stabilized at ~0.2 mA. This explains probable cause why this effect was not noticed earlier.

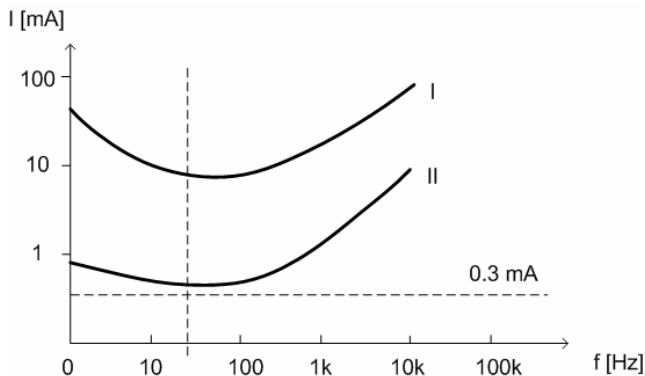


Fig. 8. Current sensitivity level dependence on frequency.

Curve I in Fig. 8. represents lower limit currents that causes person to become rigid as a result of electric shock.

#### IV. CONCLUSION

A single touch on USB connector induced an electric shock which invoked authors to conduct multiple AC measurements on multiple external HDDs.

The fact is that voltage on USB connector should not exceed 5.25 V. Measured voltages on different types of external HDDs do not comply with safety regulations defined at [4] and [5]. Voltage levels vary from AC 48.31 to 111.6 V (Table I). This high voltage level is the reason for mild electric shock to the user operating with HDD external USB case, mentioned in the introduction. Main reason why this was not noticed earlier was most probably sensitivity of human body to AC electric current as shown in figure 8.

One should be careful with computer equipment that is connected to 220 V AC power supply because it is obvious that voltages can have dangerous levels, although most have metal cases and are grounded.

Purpose of this paper was not to investigate technical or electrical construction of power supply nor existence of capacitive coupling nor reducing static electricity but to put attention to unallowable voltage levels.

Solution to this problem is in obeying connection procedures of external HDD to the computer. One must first attach USB connector to computer and then bring power supply to the external HDD. Only following this procedure the process of backup is safe and harmless for human operator. Although some manufacturers emphasize hot swap option this is not recommended by the authors of this paper.

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