The DoE Views USB Chargers As External Power Supplies

by Kevin Parmenter, Chair, and James Spangler, Co-chair, PSMA Safety and Compliance Committee

As discussed in a previous column,[1] the United States Department of Energy (DoE) has published regulations on the efficiency of external power supplies (EPSs). These rules and regulations were started by the California Energy Commission and have been taken over the DoE. The standards applied to EPSs have evolved over the years and been given level designations to indicate which version of the standard is being applied. The DoE standard currently in effect for energy efficiency in EPSs is known as level VI and the deadline for compliance with this standard was February 10, 2016.

The authors recently discovered the battery charger used for their cell phones and tablets that use a USB cable to charge the batteries is considered an EPS, and not a battery charger by DoE rules. This became clear when reading the result of the appeals submitted to the Department of Energy by a number of companies who charge the internal batteries using a USB Power Delivery system including Apple and Microsoft.[1]

These companies asked that their charger product be tested at a 10-W or 2-Adc level as the highest level verses the 15-W or 3-Adc level. The companies indicated that the products very seldom delivered 3 Adc for any extended period of time and submitted test plans that their products be tested at the 10-W, 7.5-W, 5-W and 2.5-W levels to determine their average efficiency. This was in place of the 15-W, 11.25-W, 7.5-W and 3.75-W levels. In other words, the requested change concerns the values chosen to represent 100%, 75%, 50% and 25% of the power supply's rated power to determine its average efficiency per the DoE regulation for power efficiency.

The DoE ruling does not make any reference to the European Certificate of Compliance (CoC), which asks for 100%, 75%, 50%, 25 and 10% energy efficiency numbers to create their average efficiency specification. The DoE is only dealing with the U.S. and not other countries.

The IEC Specification For USB Power Delivery

The authors also learned that the USB Power Delivery has an IEC specification called IEC 62680-1-2:2017. This has been updated to call IEC 62680-1-2:2018 when checking for the standard. The abstract for IEC 62680-1-2:2018 is shown below.[3]

- Universal serial bus interfaces for data and power - Part 1-2: Common components - USB Power Delivery specification
- IEC 62680-1-2:2018(E) defines a power delivery system covering all elements of a USB system including: Hosts, Devices, Hubs, Chargers and cable assemblies. This specification describes the architecture, protocols, power supply behavior, connectors and cabling necessary for managing power delivery over USB at up to 100 W. This specification is intended to be fully compatible and extend the existing USB infrastructure. It is intended that this specification will allow system OEMs, power supply and peripheral developers adequate flexibility for product versatility and market differentiation without losing backwards compatibility. This third edition cancels and replaces the second edition published in 2017 and constitutes a technical revision. It is also identified as Version 1.1 + ECNs through 12 June 2017.

- Markup includes ECNs through 12-June-2017:
- Add VPD Product Type
- Specification Revision Interoperability
- VCONN Swap Clarification
- Chapter 7 Source and Sink Behavior
- Battery Numbering
- Chunking Clarification
- FR Swap State Operation
- GoodCRC Specification Revision
- Slew Rate Exception for Source

Interpreting The DoE Ruling For USB Power Delivery Chargers

Based on our reading of the DoE ruling, we understand that the USB Power Delivery chargers including those rapid chargers that change the output voltage delivered to the product are all considered external power supplies. These units deliver a constant voltage unless commanded to deliver a different voltage by a communication between the portable device (cell phone, tablet or laptop).

There are communication protocols for the Qualcomn 2.0 or 3.0 systems and the latest USB type C systems. The default mode for all these is 5.0-Vdc output. Only after a handshake has been established between the charger and the consumer device will the voltage increase to what the cell phone, tablet, or laptop desires. The figure below shows a block diagram of a charger system. Please note the battery is not directly connected to the dc supply leads but must go through an internal dc-dc converter to meet the battery voltage which can vary depending on its state of charge.

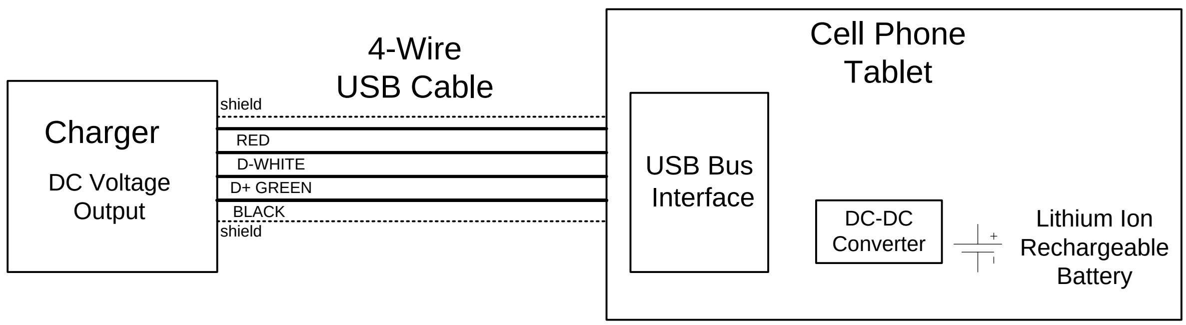

Figure. Charger and cell phone system.

These devices are not considered battery chargers since the charger and regulation is internal to the cell phone, tablet, or laptop. Most cell phones, tablets, and laptops use rechargeable lithium-ion batteries, and the full end-of-charge voltage and the end-of-life voltage is determined by the portable devices. The lithium-ion battery chemistries are slightly different for each battery manufacturer. The batteries in many cases are not easily replaced so the charging specifications for each cell phone, tablet, and laptop are slightly different to maximize battery life.

There is a DoE regulation on battery chargers[4] as there is from the California Energy Commission.[5] These battery chargers connect directly to battery for charging and include intelligence such as end-of-charge voltage, current limiting, and shorted battery cable and shorted battery protection within the charger.

Battery charging is a not a simple task in order to meet all the safety rules, along with efficiency rules and regulations. There are specifications for safety from UL, CAS, VDE, IEC, etc. A collection of these standards and rules is available in the PSMA databases. For instructions on how to sign up to view these rules and regulations in the databases, see our first column on power supply standards.[6]

References

1. **"**Notice of Decision and Order Granting Individual Waivers to Apple Inc., Microsoft Corporation, Poin2 Lab and Hefei Bitland Information Technology Co., From the Department of Energy External Power Supplies Test Procedure**,"** Federal Register, A Notice by the Energy Department on 03/16/2018.
2. "Level VI DoE Rules And Regulations For External Power Supplies—Where To Find Them" by Kevin Parmenter and James Spangler, Spotlight on Safety & Compliance, How2Power Today, April 2018.
3. IEC 62680-1-2:2018 abstract on ANSII website.
4. "2016-06-13 Energy Conservation Program: Energy Conservation Standards for Battery Chargers; Final rule"
5. "Federally Regulated Battery Chargers" Regulatory Advisory, June 7, 2018.
6. "Power Supply Standards: Which Ones Apply In Your Application?" by Kevin Parmenter and James Spangler, Spotlight on Safety & Compliance, How2Power Today, September 2017.

About The Authors

Kevin Parmenter is an IEEE Senior Member and has over 20 years of experience in the electronics and semiconductor industry. Kevin is currently vice president of applications engineering in the U.S.A. for Excelsys, an Advanced Energy company. Previously, Kevin has served as director of Advanced Technical Marketing for Digital Power Products at Exar, and led global product applications engineering and new product definition for Freescale Semiconductors AMPD - Analog, Mixed Signal and Power Division based in Tempe, Arizona.

Prior to that, he worked for Fairchild Semiconductor in the Americas as senior director of field applications engineering and held various technical and management positions with increasing responsibility at ON Semiconductor and in the Motorola Semiconductor Products Sector. Kevin also led an applications engineering team for the start-up Primarion where he worked on high-speed electro-optical communications and digital power supply semiconductors.

Kevin serves on the board of directors of the PSMA (Power Sources Manufacturers Association) and was the general chair of APEC 2009 (the IEEE Applied Power Electronics Conference.) Kevin has also had design engineering experience in the medical electronics and military electronics fields. He holds a BSEE and BS in Business Administration, is a member of the IEEE, and holds an Amateur Extra class FCC license (call sign KG5Q) as well as an FCC Commercial Radiotelephone License.

Jim Spangler is a Life Member of the IEEE with over 40 years of electronics design experience and is president of Spangler Prototype Inc. (SPI). His power electronics engineering consulting firm's priority is helping companies to place products into production, assisting them to pass government regulations and agency standards such as UL, FCC, ANSI, IES, and the IEC.

For many years, he worked as a field applications engineer (FAE) for Motorola Semiconductor, On Semiconductor, Cirrus Logic, and Active Semiconductor, assisting customers in using semiconductors. He published numerous application notes and conference papers at a variety of conferences: APEC, ECCE, IAS, and PCIM. Topics included power factor correction, lighting, and automotive applications. As an FAE, he traveled internationally giving switch-mode power supply seminars in Australia, Hong Kong, Taiwan, Korea, Japan, Mexico, and Canada.

Jim has a Master's Degree from Northern Illinois University (NIU), and was a PhD candidate at Illinois Institute of Technology (IIT). He taught senior and first-level graduate student classes: Survey of Power Electronics, Fields and Waves, and Electronic Engineering at IIT and Midwest College of Engineering.

Jim is a member of the IEEE: IAS, PELS, PES; the Illuminating Engineering Society (IES), and the Power Sources Manufacturers Association (PSMA) where he is co-chair of the Safety and Compliance Committee.

For further reading on power supply-related safety and compliance issues