

# TEST METHODOLOGY FOR DETERMINING THE ENERGY EFFICIENCY OF BATTERY CHARGING SYSTEMS

DRAFT - July 2005

## 1.0 Scope

This document specifies a test procedure for determining the efficiency of devices that charge and maintain secondary batteries. The end use of these products is not considered; this specification applies to testing of a wide range of products such as power tools, small household appliances, floor care products, flashlights, and other devices using battery charging systems.

External power supplies fitting the definition contained in **ENERGY STAR<sup>®</sup> Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies** are not covered in this procedure, even if they are primarily used to charge a battery.

## 2.0 References

The following documents were used in the development of this test specification.

International Electrotechnical Commission, Household Electrical Appliances - Measurement of Standby Power, IEC 62301

Linden and Reddy, *Handbook of Batteries, Third Edition*, McGraw Hill. New York, NY. 2002.

## 3.0 Definitions

The following definitions apply to this document.

### Battery Maintenance Mode

Battery maintenance mode is the condition in which the battery is still connected to the charger, but is fully charged. Charger may perform functions such as cell equalization, and cell discharge balance while in this mode.

### Cell Equalization

Cell equalization utilizes additional power above that of the charger's maintenance mode in order to differentially charge the individual cells of the battery pack, equalizing the voltage among all cells.

### Energy Ratio

The Energy Ratio is calculated from the measured or simulated energy use over a given time period, divided by the nominal battery energy. For the purposes of this test procedure, the energy value used is the accumulation of the non-active modes over a 48-hour period.

47  
48 Energy Ratio = (Maintenance Mode Energy + Standby Energy) / (Battery Voltage  
49 x Battery Capacity)  
50

#### 51 Maintenance Power

52 Maintenance power is the average power used in maintenance mode, taken over a  
53 period of at least 8 hours.  
54

#### 55 Nominal Battery Energy

56 The nominal battery energy is calculated by multiplying nominal battery voltage  
57 by rated battery capacity. If one or more of these values does not appear on the  
58 battery nameplate, certified data may be obtained from the battery manufacturer.  
59

#### 60 Non-Active Energy

61 Non-active energy is the energy use of the charger/battery system over a  
62 measured or simulated 48-hour period. This period consists of 36 hours of  
63 maintenance mode operation followed by 12 hours of standby mode operation.  
64 The accumulated non-active energy is the sum of the energy use in these two  
65 modes.  
66

#### 67 Standby (No-Load) Mode

68 Standby mode is the lowest power consumption mode which cannot be switched  
69 off (influenced) by the user and that may persist for an indefinite time when an  
70 appliance is connected to the main electricity supply and used in accordance with  
71 the manufacturer's instructions. Note: The standby mode is usually a non-  
72 operational mode when compared to the intended use of the appliance's primary  
73 function.<sup>1</sup> For the purposes of this specification, standby mode is the condition in  
74 which no battery is present in the charger, or where the battery is integral to a  
75 product, the product is not attached to the charger, but the charger is plugged in  
76 and drawing power.  
77

#### 78 Standby Power

79 Standby power is a measure of the average power consumption in standby mode,  
80 taken over a period of at least 1 hour.  
81

#### 82 UUT (Unit Under Test)

83 UUT refers to the charger that is the object of this test procedure.  
84  
85

## 86 4.0 Standard Testing Conditions

87

### 88 4.1 Supply Requirements

89 The following requirements shall apply to the power source from which the UUT derives  
90 its operating energy for the test.  
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<sup>1</sup> This definition is consistent with IEC 62301: Household Electrical Appliances – Measurement of Standby Power.

92 **4.1.1 Voltage**

93 The power supply shall provide stable voltage at 115V +/- 1% with THD less than 2% (as  
94 specified in IEC 62301). The crest factor of the voltage waveform must be between 1.34  
95 and 1.49.

96  
97 **4.1.2 Frequency**

98 The power supply shall provide an output frequency of 60Hz +/- 1%.

99  
100 **4.2 Ambient Requirements**

101 The following requirements apply to the room or immediate environment in which the  
102 testing is conducted.

- 103 • Air speed shall be <0.5 m/s.
- 104 • Ambient temperature shall be maintained at 23 +/-5 degrees Celsius.

105  
106 **4.3 Measurement and Instrumentation Requirements**

107 All power measurements shall be made with a calibrated power meter.

108  
109 **4.3.1 Precision Requirements**

110 Measurements of power of 0.5 watt or greater shall be made with an uncertainty of less  
111 than or equal to 2% at the 95% confidence level. Measurements of power of less than 0.5  
112 watt shall be made with an uncertainty of less than or equal to 0.01 watt at the 95%  
113 confidence level. The power measurement instrument shall have a resolution of:

- 114 • 0.01 W or better for power measurements of 10 W or less; and
- 115 • 0.1 W or better for power measurements of greater than 10 W.

116  
117 Time measurements shall be made with a precision of 1 second.

118  
119 **4.3.2 Recording Frequency**

120 Measurement values for power must be collected at the rate of at least 1 reading/second  
121 for the entire testing period.

122  
123 **4.4 UUT Requirements**

124 Both the UUT and the associated battery shall be new products, representative of the type  
125 and condition of product that a consumer would purchase in a retail setting.

126  
127  
128 **5.0 Testing Procedure**

129 Testing shall be conducted with the following steps. Note that there are two discrete  
130 testing procedures provided below: an abbreviated and full test methodology.

- 131
- 132 1. Charge battery with the UUT for a period of 24 hours or the period specified by  
133 the UUT manufacturer as the time needed to fully charge the battery under test,  
134 whichever is greater.
- 135 2. At the end of this period, continue measurement of energy used by UUT for  
136 battery maintenance mode using one of the following options:

- 137 a. Full Test - Continue measurement for a period of 36 hours (+/- 1 minute).  
138 It is acceptable to meter for longer and to only use the first 36 hours of the  
139 collected data.
- 140 b. Abbreviated Method - Measure power for at least 8 hours and take the  
141 arithmetic average of the power over the 8-hour period (28,800+ data  
142 points) and multiply by 36 hours to get the energy used over a full period.
- 143 3. Remove battery from charger and continue measurement of standby power using  
144 one of the following options:
- 145 a. Full Test - Measure energy used for 12 hours (+/- 1 minute). It is  
146 acceptable to meter for longer and to only use the first 12 hours of the  
147 collected data.
- 148 b. Abbreviated Method - Measure standby power for a period of not less than  
149 1 hour. Take the arithmetic average of the power over the full 1-hour (or  
150 greater) period (3,600+ data points) and multiply by 12 hours to get the  
151 energy used over a full period.
- 152 Note: For products that contain the battery and charging circuit within the  
153 same physical housing and use an external cord to connect to the AC power  
154 source (so called “cord/cordless” products), the standby power shall be  
155 measured with the product disconnected from the charging cord. The power  
156 draw of this class of products in standby is generally zero. This does not  
157 apply to cradle products with a separable cord.
- 158 4. Add the accumulated energy values obtained for the two periods to calculate the  
159 non-active energy use for the period.
- 160 5. Divide the non-active energy use by the nominal battery energy to obtain the non-  
161 active energy ratio.
- 162  
163

## 164 **6.0 Test Data**

165 At a minimum, the following information shall be reported for each UUT: UUT  
166 manufacturer, UUT model number, device powered by battery charging system, name of  
167 test lab, name of technician performing the test, nominal battery voltage, rated battery  
168 capacity, nominal battery energy, battery maintenance power (Wh), standby power (Wh),  
169 accumulated non-active energy (Wh), and non-active energy ratio.

170  
171

## 172 **7.0 Acknowledgements**

173 Special thanks to the International Electrotechnical Commission (IEC) for permission to  
174 reproduce extracts from page 7 of its International Standard IEC 62301 1st edition 2005-  
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