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Via email
November 4, 2010

Mr. Michael Leaon
Mr. Harinder Singh
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Subject: **Appliance Efficiency Standards for Battery Chargers (Docket # 09-AAER-2)**

Dear Messrs. Leaon and Singh:

As manufacturers of products which use Battery Charging Systems (BCS), Motorola, Inc. appreciates the opportunity to engage in a dialogue with the California Energy Commission (CEC) on the very important topic of energy efficiency for these products.

At the recent October 11, 2010 workshop on this topic, the CEC invited stakeholders to comment on the recently-published “Analysis of Standards Options for Battery Charger Systems,” which was commissioned by Pacific Gas and Electric (PG&E) and authored by Ecos Consulting. This document contains data on the performance of Battery Charging Systems in the state of California, and recommendations as to how to improve the energy efficiency of these systems.

In general, a viable energy efficiency regulation for Battery Charging Systems must be based on sound financial analysis and a solid understanding of the products to be covered, including design lifecycle, supply chain dynamics, and available technology. There are a wide variety of products that could be included in the scope of a BCS regulation, and it is critical that differentiation by appropriate product categories be made. In addition, there are products used in public safety and mission critical applications for which energy efficiency performance requirements may not be appropriate. Such devices should be excluded from the scope of regulation.

For electronic appliances which are covered, understanding of the design lifecycle is critical in order to accurately capture the costs involved with product re-design. Beyond increased component costs, such costs include engineering costs for the product re-design, capital costs for new tooling and fixtures for the manufacturing facilities, and costs for testing and regulatory approvals of new designs. In addition, an understanding of the design lifecycle leads to recognition that re-design, qualification of new components, and testing and regulatory approval adds up to at least 24 months to get new product designs to market.

After careful review, we find that significant information in these areas is over-looked or mis-interpreted by the BCS case study. Following is our feedback in these areas.

TECHNOLOGY & DESIGN ISSUES

1) Products used in public safety and mission critical applications should not be included in the scope of regulation

Typically, radio communications products sold to “mission critical” operations will utilize Nickel-based batteries, which are inherently less energy-efficient than Lithium-based batteries, yet have significant and important benefits in other areas, namely wider temperature range of operation and improved cycle-life (nearly doubled). Motorola customers within the state of California over the last four years have purchased three Nickel batteries for every one Lithium-Ion battery.

For a given charger, the efficiency when charging a Nickel-based battery pack is not necessarily the same as when charging a Lithium-based battery pack. Nickel-based battery charging systems, during rapid charge, are not efficient enough to meet the BCS CASE proposed limits. Nickel-based batteries also self-discharge much faster than Lithium-based batteries, which require more energy to maintain them in a full state of charge (which is essential for mission critical applications).

As stated above, customers buy Nickel-based batteries instead of Lithium-Ion batteries because they can operate them over a wider temperature range and they have improved cycle-life performance and cost 25% less on average. These are critical performance features for many customers with mission critical roles (see the list of mission critical roles below).

Mission Critical Customers

- Law Enforcement
    - SWAT
    - FBI
    - Secret Service
    - TSA, Port Security
    - Border Patrol
    - Patrol Vehicles (including motorcycles)
    - Detectives
    - Riot & Crowd Control
    - Prisons
- Fire & Rescue
    - Haz-Mat Response Team
    - Fire Service
    - Ambulance & Paramedics
    - Specialty Units (Mountain Rescue, Forest Fire, etc)
- Oil & Gas
    - Pipelines
    - Gas Extraction
    - Off-Shore Platforms
    - Tankers
    - Refineries
- Heavy Industry
    - Petro Chemical
    - Mining
- Transportation
    - Airport & Port Operations
    - Metro, Rail, Bus
    - Highway & Transportation Authorities
- Utilities
    - Water & Electricity
    - Nuclear Power Plants
    - Other Power Generation Plants
- Security

Figure 1 Typical Multi-Port Charger for Two-Way Radios

In addition to ignoring the need for varying battery chemistries, the BCS CASE proposed limits do not appear to account for special functions that many advanced chargers for mission critical roles require. These functions are not controlled by the user but are essential to performance, and include:

- Reconditioning of batteries: This function periodically deeply discharges a battery pack in order to eliminate irreversible and reversible memory effects. Both of these effects reduce the amount of usable energy stored in a battery. Once the battery is fully charged the batteries internal fuel-gauge will automatically calibrate. This function is deemed a mission critical function as it ensures that the stated battery capacity is accurate and maximizes the usable energy stored in the battery.

- Battery fuel-gauge calibration: Motorola Solutions Impres™ batteries have an internal fuel-gauge. This internal fuel-gauge requires periodic calibration (occurs approximately once every 30 days). Calibration is accomplished by fully discharging and then fully charging a battery. This function is deemed a mission critical function as it ensures that the stated battery capacity is accurate.

- Multi-color LED Display: This is the primary charger display. This display provides charge mode information such as rapid charge, top-off charge, maintenance charge, and reconditioning/discharging. Additionally, the LEDs also provide the user with an indication whether the battery or charger are faulted. The LEDs are observable at a distance (several yards) and under a wide range of ambient lighting conditions. This display is off when no battery is in the charging port. This function is deemed a mission critical function as it allows an end user to quickly glimpse the display and select a battery that has completed charging.

- Liquid Crystal Display (LCD): This display provides detailed charge status information such as rated capacity, available capacity (in percent of rated capacity as well as actual milliamp-hour capacity), and potential capacity (in percent of rated capacity) when fully charged. This function is deemed a mission critical function as it allows an end user to select the battery with the most amount of available capacity.

- Internal cooling fan for multi port chargers (dual unit charger and multi-unit chargers): This fan is used to dissipate the heat generated during charging and discharging. This extends the chargers operating temperature range; otherwise, chargers will need to be located in air-conditioned rooms, which is not viable for many mission critical customer use cases.

- Isolated Battery Charging Ports: Each battery charging port is electrically isolated from every other charging port in a given charger. The purpose of this design is to ensure that if a given port were to fail this would not result in a cascade failure of the other charging ports. This is a very important feature of the charger design for use in mission critical applications; otherwise an entire charger (dual unit charger or multi-unit charger) would be rendered useless.

- Rapid charging: For mission critical applications it is necessary to provide energy systems (battery and charger) that reduce the down time during charging and as a result increase the availability of fully-charged batteries. Our batteries and battery chargers are designed to rapid charge. Rapid charge consists of applying a 0.5C to 1C of charge current (C is the rated battery capacity). While this results in reducing the charge time it is less efficient than slow (overnight) charging. Mission critical customers require rapid charging.

- Battery and Charger Protection Circuits: The battery charging systems contain several protection circuits. These circuits often consist of components such as current sensing resistors, fuses, polyswitches, switching devices, and blocking diodes. Often these components are required to be in series with the charging and discharging pathways. The added resistance associated with these elements results in additional power (I^2R) or heat losses during charging and discharging. In addition, Intrinsically Safe (IS) batteries have even more protection components than standard batteries, which are certified by agencies such as Mine Safety and Health Administration and Factory Mutual (review/certify before granting approval for use). Such protection circuits are required to ensure the safety of the user during normal and faulted conditions within varying hazardous environments.

- Battery Memory: Chargers and radios periodically read and write to Impres™ batteries to ensure critical information is maintained. This information contains battery charge history, battery charge parameters, fuel-gauging information for the charger and radio, fuel-gauge calibration parameters, battery fault, and end-of-service life indication. Maintaining this data is essential to enable an accurate accounting of a batteries' capability prior to placing the battery into service in a mission critical environment. Mission critical customers utilize the Impres™ charger and battery features to ensure safe, reliable operation of Motorola Solutions radios.

In the interest of public safety for the citizens of California, the current proposal must be changed to exclude public safety/mission critical equipment from the scope of proposed regulation.

2) The proposed limits on power consumption in maintenance and no-battery mode are too low

External power supplies meeting the current California appliance efficiency requirements are allowed a no-load power of 0.5W. Meeting the maintenance and no battery power levels of 0.5W and 0.3W in the BCS CASE proposal may not be possible with external power supplies meeting the California requirements, since compliant external power supplies may consume the entire allowed power for the system, with no power margin left for the battery charger itself. Even in maintenance and no battery mode, many applications, such as public safety, require the use of

LED indicator lights to ensure units are functioning. Motorola proposes that the maintenance and no battery power levels for small battery charger systems be increased to take this into account.

3) The proposed timeline for implementation of the regulation is too short

A typical product design cycle for the products covered by this proposed regulation is 12-18 months. However, that does not take into account the further work that must be done before these products can be placed on the market, such as product compliance testing and certification. The testing requirements can be quite extensive and time-consuming, requiring 6 months or more to complete. This also ignores customer beta testing at customer locations and/or their internal qualification testing requirements.

A minimum of 24 months for implementation of a new regulation is required. On this point, Motorola is in agreement with the BCS CASE study, which states in Section 8.1 that manufacturers should be allowed "… approximately two years to source components and adjust designs."

4) The current proposal makes no allowance for Multi-port Chargers

Maintenance Mode power is consumed by the battery, charging circuitry and charge status indicators (typically LEDs for commercial/industrial products). Required Maintenance power increases in proportion to the number of occupied ports on a multi-port charger (industrial and mission critical customers require one indicator per port – they need updates on every battery in a charger "at a glance").

In the BCS CASE proposal, the difference in Maintenance and No Battery power is .5 - .3 = .2W. In the design of a multi-port charger, such restrictive limits will drive manufacturers to replace multi-port chargers with multiple single chargers, resulting in a net increase of power drawn from the grid. This solution will also increase the cost of the unit to the consumer. For example, a four-unit charger, which could use 0.65 W in maintenance mode, would be re-designed as 4 single unit chargers consuming 0.8 W to do the same work. See below for an illustration of this example.

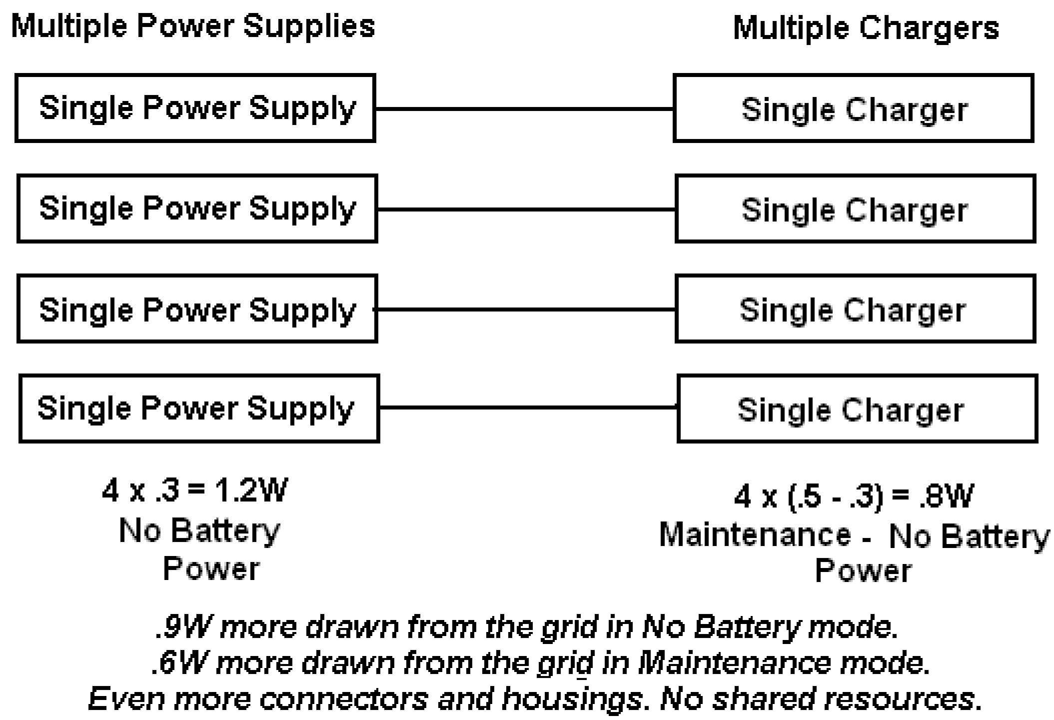

Figure 2 Multi-port charger design meeting CEC proposal

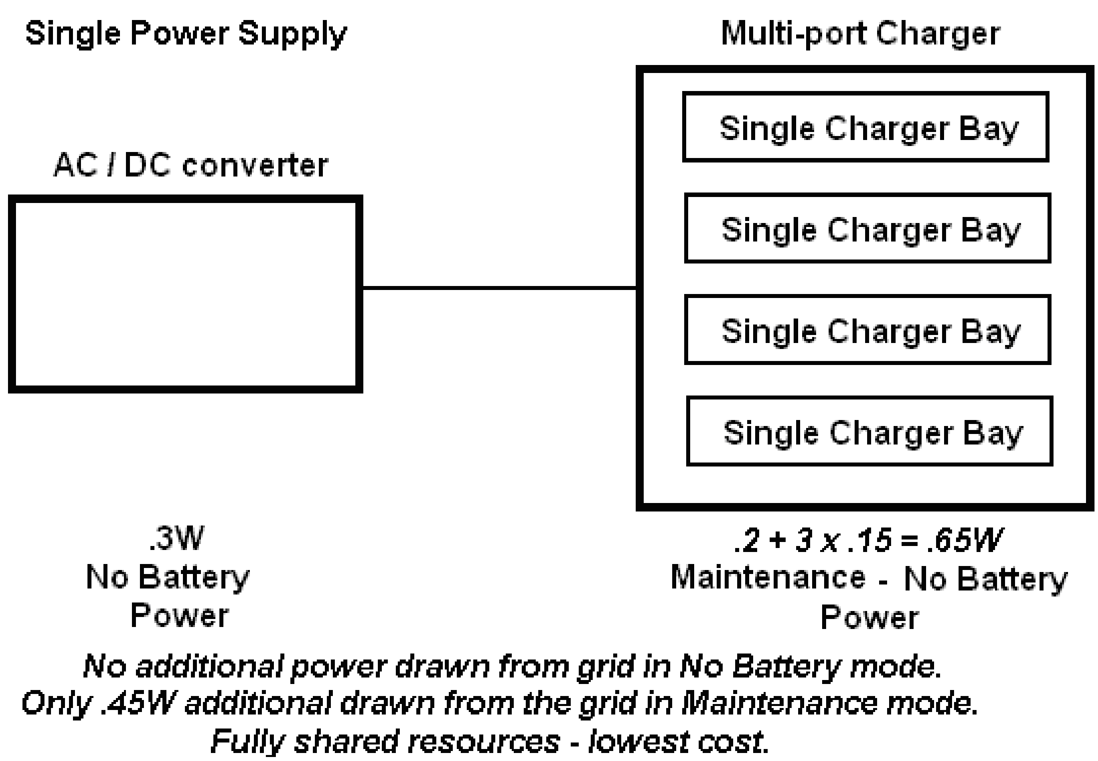

Figure 3 Multi-port charger design meeting new proposal

The approach proposed in Figure 3 is superior in energy efficiency and cost to the design in Figure 2. We strongly encourage the CEC to include allowances in power for multi-port chargers.

5) Power Factor Correction does not belong in a regulation for Battery Charging Systems

The power factor requirements for small battery charger systems on page 54 and in Appendix B of the BCS CASE report are related to the power supply of the battery charger system, and are unrelated to the battery charging functions. There is no fundamental reason to require small battery charger systems to meet power factor requirements that do not apply to other products with external power supplies (EPS).

Adding power factor correction tends to reduce the efficiency of a power supply, so it must be carefully coordinated with the efficiency requirements of the power supply.

For these reasons, the power factor correction requirements for small battery charger systems with external power supplies should be removed from the proposal. If such requirements are deemed necessary, they should be included in the next update to the appliance efficiency regulations for external power supplies.

SUPPLY CHAIN ISSUES

1) The analysis of the incremental costs to consumers to meet the proposed efficiency requirements is seriously flawed.

Page 41 of the BCS CASE report states that:

> "A battery charger can be totally redesigned and brought to market at an incremental manufacturing cost near zero. By replacing some components with more efficient ones, incremental costs near $0.40 are common."

Similarly, the presentation by Ecos states that:

> "Added cost is on average $0.30 to save $0.78 per year over product lifetime (present costs)."

These estimates seem to have only considered the cheapest possible component costs, and have not included the fixed costs of engineering redesign, tooling, quality testing, regulatory approvals, and customer acceptance testing.

An estimate of the amount of engineering work needed to re-design our portfolio of affected products for North America shows that re-engineering costs alone for single-unit chargers would increase the product cost by at least 25%. For multi-unit chargers, the additional design costs would add 15% to the product.

In addition, when the battery charging circuit is changed to comply with the proposed BCS efficiency requirements in California, the regulatory certifications and test reports for product safety (for example, Underwriters Laboratories Listing and Certification Body (CB) certification) and electromagnetic compatibility (for example, FCC, CTIA and CISPR compliance) must be updated. If a product is marketed globally, as many are, additional certifications such as RTTE or CSA (Canadian Standards Association) will be required. Products used in medical settings (e.g. handheld scanners) may require FDA certification. When a product is sold in many countries, the costs for such regulatory certification updates can easily reach $25,000 per product. If we sell only 1,000 BCS per year for five years, the regulatory cost per unit will be $25,000/(1000x5) = $5. For BCS near the end of the support cycle, the volume per year and the number of years will both be lower, and the regulatory cost per unit will be much higher.

2) The lifecycle estimates for small industrial products is highly inaccurate

Handheld products with battery chargers may have a shorter life-span than the overall communications systems they support. The life of the entire system must be considered. Public safety systems are designed to operate for well in excess of 20 years. These systems are very complex and expensive and must be maintained in peak condition to perform in mission critical situations. The ongoing support for these systems drives a low sales volume of products over very long periods of time. In these cases, the fixed costs when divided by the total number of sales are very significant on a per unit basis. Due to the life expectancy of these systems we maintain replacement parts, assemblies and key equipment like chargers long after sales are discontinued through our normal distribution channels. Re-design of these system components is not always possible for older systems, as the required system-level testing cannot be done because the older system components are no longer on the market. The CEC should not force the disposal of entire communications systems because spare parts will be suddenly unavailable. This is very costly to public agencies and results in the unnecessary generation of electronic waste. These systems should be excluded from the proposed BCS energy efficiency requirements in California.

3) The lifecycle estimates for Mobile Phones do not take into account the Universal Charger Initiative currently underway, and grossly over-estimate potential cost savings

In the consumer appliance industry, the trend among certain products is away from providing bundled external power supplies, particularly with appliances that have a short lifecycle, such as mobile phones. Motorola and many other industry leaders have joined with the Global System Mobile Association (GSMA) to develop a “universal charger” for mobile phones. One of the goals of the group is that by January 1, 2012, the majority of all new mobile phone models available will support a universal charging connector. A universal charger will make life much simpler for the consumer, who will be able to use the same charger for current AND future handsets, without having to purchase a new charger each time they buy a new phone. The GSMA estimates this development will result in potentially 50 percent less chargers being manufactured each year, which means consumers will continue to use chargers which were previously purchased for half the new phones placed on the market. It appears the BCS CASE study did not take this into account, even though it has a significant impact on the cost-benefit analysis for this product category, effectively reducing the potential costs savings by 50%.

4) The proposed regulations for BCSs should have an exemption for spare and service parts

In line with the already established CEC requirements for EPSs, CEC should include an exemption for spare and service parts in any proposed BCS regulation. Many electronic products use specifically designed Battery Charging Systems. Spare and service parts for these systems must be available to both consumers and to product service centers during the useful life of a product. In addition, it is important to recognize that most public safety/mission critical and enterprise communications products, such as radios that use BCSs, have a very long life for which compatible replacement parts need to be supported. Otherwise such products could not continue to be used, which then would lead to greater costs for the public safety community, as well as an increase in generation of electronic waste. The European Union has addressed this issue by allowing replacement parts for products placed on the market prior to the effective date of WEEE/ROHS to continue to be repaired with parts as originally-designed, and we encourage the CEC to consider this approach as well.

Furthermore, California law itself requires that manufacturers provide spare parts for at least seven years for electronic and appliance products (California Civil Law 1793.03):

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(a) Every manufacturer making an express warranty with respect to an
electronic or appliance product described in subdivision (h), (i), (j),
or (k) of Section 9801 of the Business and Professions Code, with a
wholesale price to the retailer of not less than fifty dollars ($50)
and not more than ninety-nine dollars and ninety-nine cents ($99.99),
shall make available to service and repair facilities sufficient
service literature and functional parts
to effect the repair of a product for at least three years after the
date a product model or type was manufactured, regardless of whether
the three-year period exceeds the warranty period for the product.
   (b) Every manufacturer making an express warranty with respect to an
electronic or appliance product described in subdivision (h), (i),
(j), or (k) of Section 9801 of the Business and Professions Code, with
a wholesale price to the retailer of one hundred dollars ($100) or
more, shall make available to service and repair facilities sufficient
service literature and functional parts to effect the repair of a
product for at least seven years after the date a product model or type
was manufactured, regardless of whether the seven-year period exceeds
the warranty period for the product
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It is not uncommon for the specialized communications equipment manufactured by Motorola to have a field life of 15 to 20 years, and service parts should be available for the life of the product in order to minimize expenses to the customer and to minimize waste generation. Costly re-design requirements will limit the availability of these replacement parts. Motorola urges the CEC to exclude spare parts and service parts from scope of the proposed regulation or otherwise allow for maximum product life for these low-volume items.

In addition to the above, Motorola Inc. offers the following input on the CEC Energy Efficiency Battery Charger System Test Procedure Version 2.2

1) The proposed test procedure does not clearly define how to select batteries for testing

In the Energy Efficiency Battery Charger System Test Procedure Version 2.2, Part II, Table 3, the technician is instructed in row 5 to select the batteries with the "lowest voltage" or the "highest voltage" for testing. However, no definitions are given for these terms, and multiple interpretations are possible:

- Rated Battery Voltage
- Desired - End-of-Discharge Battery Voltage
- Midpoint voltage during 0.2C discharge
- Average voltage during 0.2C discharge
- Battery Discharge - starting battery voltage
- Battery Discharge - Ending battery voltage

We respectfully request that CEC clarify the definitions for "lowest voltage" and "highest voltage" in the test procedure.

2) The proposed test procedure needs clarification regarding in-vehicle electronics, which should not be in the scope of future regulation

In the CEC Energy Efficiency Battery Charger System Test Procedure Version 2.2, Part A General Scope, the test procedure states “The scope of this procedure is limited to battery charger systems that are rated for ac input of 600 volts or less and that connect to the utility grid with a plug or are permanently connected.” But in Part 1, Section I.D, the test procedure states “If the UUT is intended for operation only on dc input voltage (and does not include an EPS), it shall be tested with one of the following input voltages: 12.0 V dc for products intended for automotive, recreational vehicle or marine use, 5.0 V dc for products drawing power from a computer USB port, or the midpoint of the rated input voltage range for all other products.”

The stated scope of the test procedure clearly excludes in-vehicle “DC-in, DC-out” battery charging systems which are not connected to the utility grid. However, there are instructions in the test method for testing these types of BCS. The references to testing “DC-in, DC-out” devices should be removed to reduce confusion with test procedure application.

In addition, in-vehicle electronics which do not connect to the utility grid should not be included in the scope of future energy efficiency regulations for these products, as they do not consume energy from the utility grid and therefore no cost-savings to the consumer can be demonstrated.

3) Discharge Threshold should not be specified in a test method

We understand the test procedure is intended to simulate the most accurate charging scenarios for individual battery charging systems and allows individual products to be tested in real world conditions. For example, most devices will not allow the battery to be fully discharged and will force a shut down of the device to prevent a full discharge of the battery. Battery Charging Systems are optimized to operate with a specific discharge thresholds based on the chemistry of the cell, the cell manufacturers requirements, and the design of the device itself. We believe that any attempt to set an artificial threshold value would impede technology and would in fact constrain designers and manufacturers in such a way that it would not be beneficial to the overall goal of saving energy.

We believe that any rulemaking must incorporate the flexibility to allow designers to optimize energy efficiency, and for any battery charging system must allow the test method to use the designed "low battery warning threshold" as the discharge level of the battery.

Motorola, Inc. recognizes the importance of energy efficiency and has long striven to increase energy efficiency across our diverse product portfolio. As an example, our latest VIP Series IPTV set-tops use advanced power management technology, which saves almost a quarter of the power required by the previous models. In addition, we have reduced the average standby power of our cell-phone wall chargers by at least 70 percent since 2000, and continue to improve. We continue to work on saving energy in other ways as well, such as developing alternative-energy solutions for our products as well as purchasing electricity from renewable sources as a member of US EPA’s Green Power Leadership Club.

Motorola, Inc. has actively participated as a stakeholder in the US Department of Energy’s current process to develop energy efficiency standards for Battery Charging Systems. It is imperative that the state of California join in the collaboration and work together with the US DOE to develop a national standard for these products. Short-lived regulations specific to California will only result in product shortages for the California consumer and an increase in costs and inconvenience when these consumers are forced to purchase products in other states.

Motorola, Inc. appreciates the opportunity to provide this input to the California Energy Commission and looks forward to continuing a dialogue on the important topic of energy efficiency for Battery Charging Systems.

Sincerely,

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