Safety Guard specifications

Maximum input voltage	30VDC	
Maximum charge current	20A	
Maximum discharge current	10A	
Maximum output voltage	*Configuration*	*Max. Safety Guard output voltage*
	2s pack (8.4V)	8.4V ± 0.1V
	3s pack (12.6V)	12.6V ± 0.15V
	4s pack (16.8V)	16.8V ± 0.2V
Dimensions	1.06" (27mm) wide x 1.4" (35.5mm) long x 0.35" (8.5 mm) high	

Kokam/USA limited warranty for charging products

Kokam/USA warrants this product to be free of manufacturing defects for the term of one year from the date of purchase. Should any defects covered by this warranty occur, the charger shall be repaired or replaced with a unit of equal performance by Kokam/USA or an authorized Kokam/USA service station.

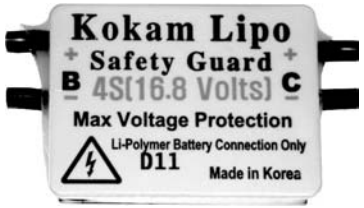
Limits and exclusions

This warranty may be enforced only by the original purchaser, who uses this product in its original condition as purchased, in strict accordance with the product's instructions. Units returned for warranty service to a Kokam/USA service center will be accepted for service when shipped postpaid, with a copy of the original sales receipt or warranty registration form, to the service station designated by Kokam/USA.

This warranty does not apply to:

- Consequential or incidental losses resulting from the use of this product.
- Damage resulting from accident, misuse, abuse, neglect, electrical surges, reversed polarity on connectors, lightning or other acts of God.
- Damage from failure to follow instructions supplied with the product.
- Damage occurring during shipment of the product either to the customer or from the customer for service (claims must be presented to the carrier).
- Damage resulting from repair, adjustment, or any alteration of the product by anyone other than an authorized Kokam/USA technician.
- Installation or removal charges, or damage caused by improper installation or removal.

Call (301) 668-4280 for more information about service and warranty repairs.



Safety Guard

Voltage-limiter for charging Lithium Polymer packs

LIPOSG-2S for 2s packs

LIPOSG-3S for 3s packs

LIPOSG-4S for 4s packs

About Safety Guard

Lithium Polymer (LiPo) cells and packs can be destroyed during charging by applying a voltage that's too high. Safety Guard is a voltage-limiting device that prevents overvoltage during LiPo pack charging.

What happens when LiPo charge voltage is too high? With as little as 10 minutes of overvoltage (6V per cell), the cell envelope begins to expand, which severely damages the cell. Continued overvoltage causes the envelope to swell from increasing internal gas pressure. Under extreme conditions, the envelope may vent (open) in less than 20 minutes. This destroys the cell. If supply current is high, venting may be accompanied by flames.

Connected between charger and pack, Safety Guard limits charge voltage to 4.2 volts per cell. When Safety Guard's output voltage exceeds this amount, Safety Guard disconnects the pack from the charger—minimizing the chance of cell damage and dangerous conditions.

Safety Guard is available in three configurations:

FMA Part No.	For pack type*	Nominal pack voltage	Safety Guard voltage limit
LIPOSG-2S	2s	7.4V	8.4V
LIPOSG-3S	3s	11.1V	12.6V
LIPOSG-4S	4s	14.8V	16.8V

*For example, 2s refers to a pack with 2 cells connected in series.

Note: Safety Guard does not limit current to the pack being charged. While Safety Guard will shut down if current exceeds 20A, it does so to prevent damage to its own circuitry. Excessive charge current will damage or destroy Lithium Polymer cells and packs. In all charging situations, the user is responsible for limiting charge current to 1C, where C = pack capacity (usually stated in mAh or Ah).

The primary application for Safety Guard is to prevent overvoltage when charging LiPo packs with a current-regulated LiPo charger. Many LiPo chargers have selectable output voltages for charging LiPo packs in various configurations (2s, 3s, 4s, etc.). If you accidentally apply a too-high voltage to a pack, the pack will be damaged or destroyed. An example would be attempting to charge a 2s pack (7.4V) with voltage intended for a 3s pack (11.1V). A 2s Safety Guard between the charger and pack would prevent overvoltage damage in this example.

continued

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FMA Direct

A second application for Safety Guard is to charge LiPo packs from sources not specifically designed for that purpose. Sources described in this manual include:

- Certain wall plug-in DC power supplies.
- Radio control transmitter charger.
- High current sources such as a 12V lead-acid battery or variable voltage DC power supply.
- NiCd/NiMH fast chargers for up to 7 NiCd cells.

A third application for Safety Guard is to prevent LiPo packs from being discharged below 2.5V per cell. When discharged below 2.5V per cell, LiPo pack performance and life rapidly decreases. Because Safety Guard disconnects a LiPo pack from the current drain in this application, uses in radio control are limited.

CAUTION: Safety Guard does not eliminate the need for safe charging practices. Read and understand FMA's "Warning: Safety Precautions for Lithium Polymer and NiCd cells/packs stocked by FMA Direct," provided with Safety Guard.

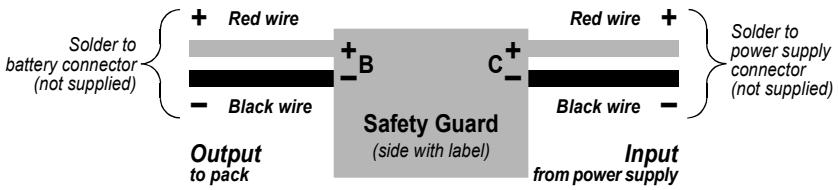
Precautions

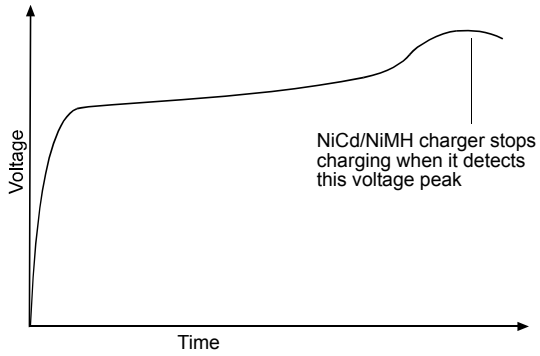
- Safety Guard is designed specifically for charging Lithium Polymer (LiPo) and Lithium Ion cells and packs. **Do not** use Safety Guard to charge NiCd, NiMH or any other type of battery.
- Except as described in this manual, never charge LiPo batteries with a charger designed for NiCd, NiMH or any other type of battery chemistry. LiPo cells require a special charging sequence not provided by chargers made for other battery technologies.
- For best results, use a 1C charge rate* (where C = cell/pack capacity). Charging at a 1C rate takes about 1 hour to reach 90% capacity (for a fully discharged cell/pack). Charge rates greater than 1C may reduce cell capacity.* Extreme charge rates **will** damage cells.
- Follow all guidelines for charging, discharging, handling and storing LiPo cells.*
- See additional warnings sheet provided with this device.

*For details, see the *Kokam/USA Lithium Polymer Cell application manual*, AN000001, available in the Support section of the Web site.

Preparing Safety Guard for use

1. Solder connector(s) appropriate for the power supply to the Safety Guard input wires.
2. Solder connector(s) appropriate for the LiPo pack to the Safety Guard output wires.





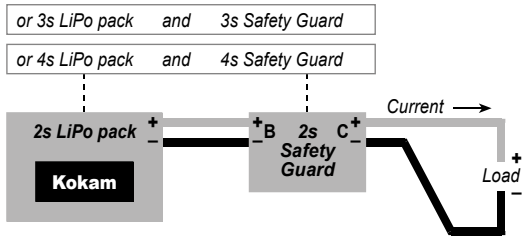
Lead acid batteries have similar characteristics. LiPo chemistry doesn't exhibit this voltage peak during charging.

NiCd/NiMH chargers for packs of more than eight cells have output as high as 50 volts. (If powered by a 12 volt source, such chargers use a booster circuit to achieve this voltage.) If you attempt to charge a LiPo pack with this kind of NiCd/NiMH charger, voltage increases toward the charger's maximum because the charger never senses a voltage peak (as it would when charging a NiCd/NiMH pack). Without Safety Guard, this voltage *will* destroy a LiPo pack with dangerous results. Using Safety Guard *might* protect the LiPo pack, but would destroy the Safety Guard. Worst case, both the LiPo pack and Safety Guard would be destroyed.

Using Safety Guard for over-discharge protection

Safety Guard can also be used to monitor pack voltage during discharge. It will disconnect the pack from the current drain if pack voltage drops below 2.5V per cell. Maximum discharge current is 10A.

However, Safety Guard is not practical for controlling over-discharge in many RC applications, as it will completely disconnect voltage to the device being powered by a LiPo pack. Also, many RC applications exceed Safety Guard's 10A discharge rating. A Speed 400 motor, for example, draws up to 12A when powering an electric aircraft.



Using Safety Guard with certain NiCd/NiMH fast chargers

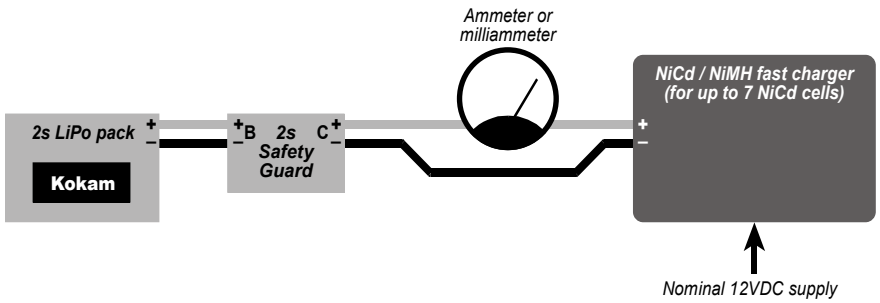
CAUTION: Do not charge LiPo packs with a high cell count fast charger, such as FMA's FC700 Super Nova. When Safety Guard stops the charge, some current may continue to flow. If the charger thinks the pack is still connected, its output voltage may increase, possibly to as high as 50V. If Safety Guard is forced to dissipate high voltage/ high current indefinitely, it may fail, which may damage the pack and possibly cause a fire. **If your fast charger can charge packs of more than 7 NiCd/NiMH cells in series, do not use it to charge LiPo packs through Safety Guard.** Such chargers have a DC/DC converter that boosts input voltage from a 12V power source to charge packs with more than 7 cells.

You can charge 2s LiPo packs with Safety Guard and a NiCd/NiMH fast charger rated for 7 cells or less. These fast chargers output constant current, but LiPo packs must be charged with current limiting followed by voltage regulation. The result is that a fast charger will apply too much voltage near the beginning of the charge cycle. Charging this way shouldn't damage the LiPo pack, but the pack won't reach the same charge level as it would with a dedicated LiPo charger. For best results with this arrangement, use a lower current setting. The lower the current, the more charge can be applied to the pack. Safety Guard terminates charging when its output voltage reaches 4.2V per cell.

You *may* be able to charge 3s LiPo packs with a 7-cell NiCd/NiMH charger. 3s LiPo packs require 12.6V input to achieve full charge. Final charge level depends on whether the charger can deliver that voltage when powered from a nominal 12V power source, such as a lead acid battery.

NiCd/NiMH charger requirements:

- Fast charger rated for 7 or fewer NiCd/NiMH cells in series (i.e., does *not* have a DC/DC converter for charging 8 or more cells).
- Output current of 1C or less (where C = pack capacity).



Why you can't charge LiPo packs using NiCd/NiMH chargers

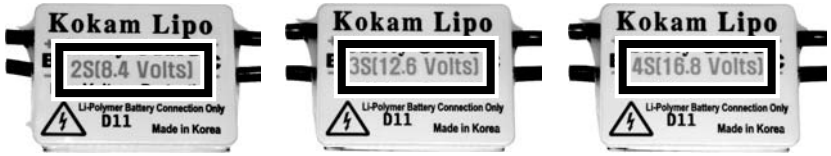
The setup described above shows how to charge a 2s LiPo pack using a 2s Safety Guard and a NiCd/NiMH charger rated for 7 cells or less. **Other than that specific combination, you can't safely charge LiPo packs with NiCd/NiMH chargers.**

NiCd/NiMH chargers output constant current and use peak detection to terminate charging. During a typical charging cycle, charger output voltage follows a predictable pattern associated with NiCd/NiMH chemistry (see graph on next page).

Preparing to charge a LiPo pack

1. Select a Safety Guard corresponding to the number of cells in the pack to be charged:
   - For a 2s pack, use a 2s Safety Guard.
   - For a 3s pack, use a 3s Safety Guard.
   - For a 4s pack, use a 4s Safety Guard.

   Identify Safety Guards by the "S" number and voltage printed on the label:



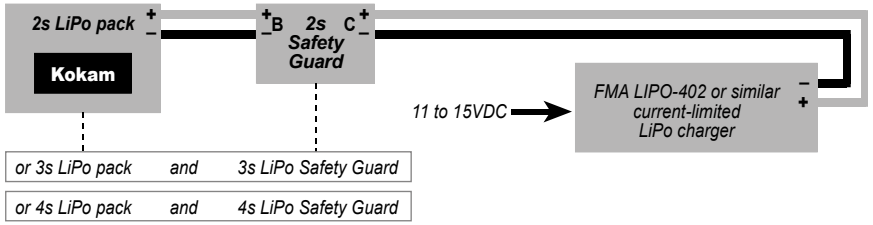
2. Connect the Safety Guard output to the LiPo pack.
3. Connect the Safety Guard input to the output of a DC power source.

Using Safety Guard with a current-regulated Lithium Polymer charger

In this application, Safety Guard prevents accidental over-voltage during charging. The LiPo charger limits current to 1C.

Current-limited LiPo charger requirements:

- Nominal charger output voltage equal to nominal pack voltage.
- Charger output current of 1C or less (where C = pack capacity).

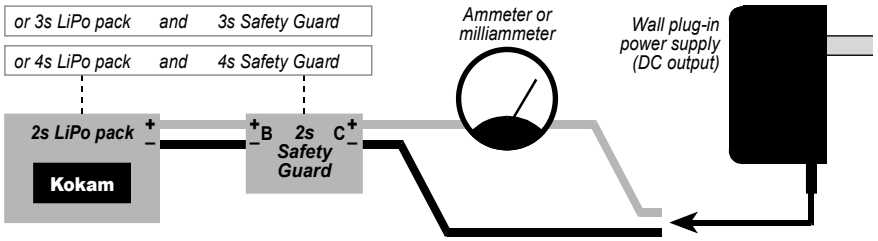


Using Safety Guard with a low current power source

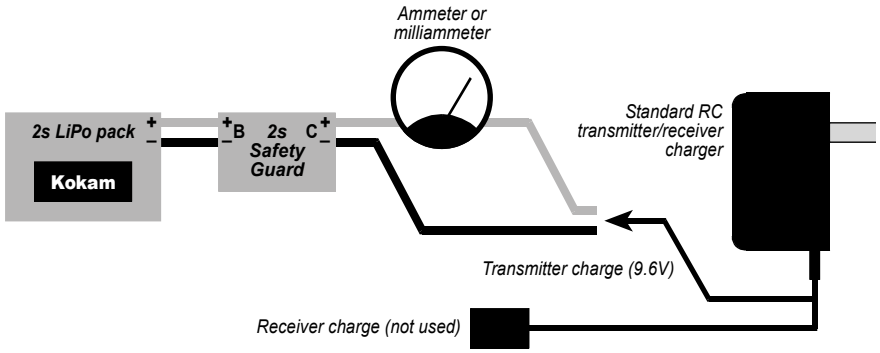
Many wall plug-in DC power supplies have specified output currents in the same range as LiPo charge current limitations. For example, a 12VDC, 1A power supply—when used with a 3s Safety Guard—could be used to charge a 3s (11.1V) 1A LiPo pack at 1C (or a 3s 2A pack at 0.5C, etc.). You must electrically connect the wall plug-in power supply to the Safety Guard by soldering or with appropriate connectors. Monitor pack charging current with a series ammeter or milliammeter to assure it does not exceed 1C.

DC wall plug-in power supply requirements (check supply's label for specifications):

- Output voltage equal to or greater than nominal pack voltage at desired current limit of 1C (maximum power supply output voltage of 30V).
- Specified current of 1C or less (where C = pack capacity).



An RC transmitter/receiver wall plug-in charger, when used with a 2s Safety Guard, can charge 2s LiPo packs. Such chargers deliver 9.6VDC at less than 100mA through the transmitter charge lead, sufficient for charging most 2s LiPo packs at less than 1C.



Using Safety Guard with a high current power source

Typical high current power sources include lead-acid batteries (such as a car battery or field battery) and variable voltage output DC power supplies. **Safety Guard output current must be limited because these sources are capable of supplying currents far exceeding safe levels for LiPo charging.**

- If the power supply has fixed output voltage: You must limit pack charging current to 1C or less using a series resistor. Monitor pack charging current with a series ammeter or milliammeter until you determine the resistor value that limits current to 1C or less.
- If the power supply has variable output voltage: Monitor pack charging current with a series ammeter or milliammeter. At the beginning of charge, reduce power supply output voltage to limit current flow to 1C or less. As the pack voltage increases, increase output voltage until the power supply regulates voltage at 4.2V per cell.

CAUTION: Do not disconnect the LiPo pack while voltage is applied to it. The sudden decrease in load may cause the power supply to increase voltage before the pack is fully disconnected—and this voltage spike may damage the Safety Guard. Here is the correct procedure for stopping charging:
1. Turn off the power supply.
2. Wait until the power supply's output voltage drops to zero volts.
3. Disconnect the pack from the Safety Guard.

High current power source requirements:

- Output voltage equal to or greater than nominal pack voltage at desired current limit of 1C (maximum power supply output voltage of 30V).
- If power source does not have variable output voltage, Safety Guard output current must be limited by series resistance to 1C or less (where C = pack capacity).