

Opportunity Charging with the State-of-the Art SAFEFlex Chargers

Overview

Opportunity charging is a practice applicable to both Lead Acid and Lithium-ion (Li-ion) batteries for motive power systems and especially useful for Material Handling (MH) equipment. Fast charging is a key differentiator for Lithium-ion batteries. Because the chemistry allows fast charging without damaging cycle life, Our Lithium SAFEFlex Li-ion batteries can be charged opportunistically during breaks and don't require battery swaps.

Green Cubes' state-of-the-art Lithium SAFEFlex chargers employ high-frequency technology for the most compact, efficient for the widest voltage range available on the market today. Multiple outputs and automatic voltage detection via CAN communication enable simultaneous charging of multiple trucks with a single utility connection. The modular design allows an entire fleet, from pallet jacks to forklifts, to be serviced, opportunity charging around the clock.

- Lithium batteries can be fast charged during breaks without affecting cycle life
- Charger with voltage detection enables charging of multiple trucks with a single utility connection
- High-frequency charger is compact & efficient, pair with Lithium SAFEFlex Batteries for opportunity charging and 24/7 operation



Charging Li-ion Batteries

Li-ion batteries are preferably charged using a Constant Current / Constant Voltage (CC/CV) charge regime, but most MH equipment batteries are designed to accept both CC/CV and FLA charge regimens. Regardless of the state-of-charge of the battery when connected to the charger, the battery will efficiently accept the power and increase its state-of-charge. Whether the battery has been connected to the charger for 15 minutes or two hours, that battery can be immediately discharged and used by the MH equipment as there is no need to cool or rest a Li-ion battery after charging.

The Li-ion cell chemistry has numerous chemical variants. Lithium Iron Phosphate (LFP) chemistry is the predominant chemistry used to power MH equipment: LFP features:

- exceptionally long cycle life (2000 - 4000 cycles to reach 80% of the original capacity)
- high power capabilities for both charge and discharge
- lower energy/density than other Li-ion variants.

The long cycle life means an LFP battery can be installed and remain in the equipment for 8-10 years. More importantly, since LFP chemistry can accommodate high power delivered to and from the battery, a depleted LFP battery can accept a full charge in a little over one hour (i.e. 1 C rate) and it can be delivered throughout the shift when the operator has a break or lunch. Li-ion is the optimal chemistry for opportunity charging.

Best Practices for Opportunity Charging

1. Do a power study where the battery activity is monitored. Based on the data, one can determine whether there are adequate opportunities for charging throughout the shift. If there is no down-time for the equipment throughout the shift, then the batteries will need to be charged for an hour before the shift.
2. Single shift vs. multi-shift operations can determine the value of opportunity charging. If the enterprise operates a single shift operation, a fully charged Li-ion (or FLA) battery should power that vehicle through the shift. When a second (or third) shift is needed, then opportunity charging can be used to recharge in increments and ensure that the equipment is powered through all the shifts.
3. Rather than charging FLA batteries in a centralized battery maintenance room, distributed the Li-ion charging stations near break rooms and heavy work areas. Decentralized charging stations eliminate the operator's travel time from their work area to battery maintenance room as well.
4. Assess existing FLA chargers to determine if they are compatible with the Li-ion batteries.
5. Assess the power output of the existing FLA and Li-ion charging infrastructure. The power rating on the charger must be much higher when opportunity charging.
6. Consider a multi-voltage battery if opportunity charging is desired but there is not adequate down-time within a shift.



SAFEFlex Chargers

The Lithium SafeFlex Battery Charger is designed to operate with Material Handling (MH) and Ground Support Equipment (GSE) Lithium-ion batteries. This charger has universal AC power input, supports full Level 3 charging via a CANBus communications with the battery, has a touchscreen display, provides unity power factor with very low iTHD which results in very high charging efficiency, and has the smallest footprint in the MH and GSE charger industry.

This charger is offered in 15 KiloWatt (kW) and 30 kW models. Each model supports up to three simultaneous charging ports, and performs voltage auto-detect for each of the charging ports. This charger is scalable down to 5 kW and up to 30 kW, while each module has a default power level of 15 kW.

This charger supports local and remote management with an embedded Internet of Things (IoT) processor which provides real-time performance information of each charge session with a Lithium-ion battery. Local support and remote administrative staff can review and manage charger/truck integration and overall fleet performance. Access to the Internet is supported via an Ethernet port, WiFi communications, or GSM cellular communications via Sim card slot.

With this charger connected to our Maestro cloud-based applications, fleet managers can monitor all critical charging performance parameters such as voltage, temperature, charge/discharge current, charge time connected to the battery, Kilo-Watts delivered per charge session and warnings errors.

Features

- Modular 15 kW and 30 kW models
- Level 3 charger with CANBus communications
- IoT Management via wireless and wired communications
- Real time performance monitoring via Maestro cloud-based application
- Easy configuration via touchscreen display
- Industry's highest energy density and efficiency, with smallest footprint.



Features of SAFEFlex Batteries

Ease of Use

- 30 kWh, 48V 600Ahr battery can be fully charged in less than 1 hour at 320 amps
- Configurable dot matrix battery discharge indicator provides critical battery information along with errors or other important runtime data
- No change to truck required, CAN communication for lithium ready equipment
- Utilizes existing 4/0 cabling
- No Maintenance
- No Watering
- No Equalization Charging
- No Battery Washing Needed
- Utilizes Lithium Iron Phosphate battery chemistry for increased safety and stability
- Voltage, Current, and Temperatures are continuously monitored by Green Cubes Technology's custom Battery Management System (BMS) which controls the internal safety contactors or disconnects the fuse
- Constructed from UL approved components

Features of Lithium SAFEFlex Chargers

- Fast charging
- Small and lightweight
- Wall-mounted
- Same form factor for 15 kW and 30 kW
- 2x15kW Power Modules
- Up to three out-puts, 6 different configurations
- 3 batteries different charged simultaneously
- 97% efficiency
- No input current distortion
- IP55 for outdoor use (future models)
- Display and IoT communication



Although opportunity charging is not new in this market, lithium improves upon the existing concept; it brings is a true fast opportunity charge because Lithium can truly be charged in a one hour time-frame.

Allowing the operator the freedom to just plug the battery in during a lunch or break and a short break is really can bring 25 percent back to the battery or more being on the brake. Lithium enables a 24/7 operation without having to do battery swaps.

Also, there's no degradation with overcharging or undercharging, because the lithium batteries are protected by the battery management system. They're able to be continuously plugged in during off periods. The operator doesn't have to worry about the state of charge and it is kept at an optimal state of charge. There's no worry about having an overcharge battery, allowing for disruption of routines.

Performance Specifications for SAFEflex Chargers

Parameter	Description	Value
General	Battery Voltage Range (Auto Detect)	20 – 118 V
	Maximum Output Charging Current	200 A per output (x3) or 600 A output (x1) on 30kW model
	Power Loss in Standby Mode	< 10 W
	Weight (kg)	15 KW = 32 kg 30 KW = 42 kg
	Dimensions (W x D x H)	600 x 300 x 350mm
	AC Input Supply	380 – 480 Vac, 3-phase (3W+PE)
	Maximum AC Input current	50 Amps
Input	Line Frequency	50 / 60 Hz
	Efficiency	> 97 %
	Power Quality	PF > 0.99; iTHD < 5%
	Connector and Wire	Phoenix Connector P/N: 1932504 6 AWG 4core
	15 kW Model	100 – 300 A at 20 – 59 Vdc, or 50 – 150 A at 60 – 118 Vdc
	30 kW Model	200 – 600 A at 20 – 59 Vdc, or 100 – 300 A at 60 – 118 Vdc
	Cable Length	Custom lengths
Output	Connector Options	SB350, Euro A320 Connector
	Connector and Wire	M6 Studs x 2 per line
	Wireless	Wi-Fi, GSM (via SIM card slot)
Communication	Wired	Ethernet, USB
	Loading Method	User Control
Charge Control	Charging Profile	Default Factory Setting, User Configurable
	Operating Temperature	-20°C to +50°C
Environmental	Storage Temperature	-40°C to +80°C
	Relative Humidity	Max. 85%
	Ingress Protection Rating	IP21
	Enclosure Ratings	NEMA 1
Agency Approvals	United States	UL 1564
	Canada	CSA 22.2 107.2-01
	Europe	IEC 62477-1

ABOUT GREEN CUBES TECHNOLOGY

Green Cubes Technology develops and manufactures a complete portfolio of lithium power systems that enable its OEM and enterprise customers to transition from Lead Acid and Internal Combustion Engine (ICE) power to Lithium-ion battery power. Green Cubes utilizes proven hardware and software platforms to build the most reliable lithium battery systems in its industries. With over 300 employees across six countries, Green Cubes has been producing innovative, high-performance and high-quality products since 1986. For more information, email info@greencubes.com or visit greencubes.com.