



Keatec Energy Technology Guide Battery Basics

Keatec Energy designs, manufactures, installs and services DC and AC uninterruptible power solutions for Telecommunication, Commercial Information Technology (IT), Public Safety and Industrial clients across the Americas.

Table of Contents

	Page
Nominal Capacity vs Actual Capacity	3
Final Discharge Voltages	3
Storage - Self-Discharge	3
Charging - CV and CC	4
Multi-Stage Charging - CC CV	4
Battery Life	5
Factors Affecting Lead Acid Battery Life and Performance	5
UPS Battery Systems - Key Features	6
UPS Battery Systems – Design Considerations	7
UPS Battery Systems – Maintenance Considerations	7
Battery FAQ	8
Sealed VRLA and AGM Batteries	10
NiCd Batteries	11
Lithium Batteries	13
Why Keatec Energy? - We Bring the Energy	15

Headquarters
Surrey, B.C. CANADA

Telephone
+1 844 307 7998

Sales Showroom - Mexico & Latin America
Oficina A-407, Laguna de términos 221,
Col Granada, Ciudad de Mexico
CP 11460 Mexico

Telephone
(+52) 55 7258 0352

keatecenergy.com
sales@keatecenergy.com

Nominal Capacity vs Actual Capacity

A Lead type battery is a pack of battery cells, nominally 2V per cell.

The capacity of a battery is the available amount of electrical energy which can be obtained from a fully charged cell.

- The nominal capacity of a cell is expressed in ampere hours (AH), which is a current-time product.
- The nominal capacity of a battery is measured at a set discharge rate (C Rate), usually the 10 hour or 20 hour rate, at 25 °C to a cut-off voltage of 1.75 volts per cell.

The actual capacity value is dependent upon the discharge current (C Rate), the temperature during discharge, the final cutoff voltage and the cycle life history.

- At a high discharge rate, battery capacity decreases and at a low rate capacity increases.
- At low temperature the discharge capacity of the battery decreases and at high temperature it increases.
- Discharging and charging (cycling) of a lead acid battery is an electrochemical process that ultimately results in the destruction of the lead plates (shedding) and the degradation of the electrolyte liquid which reduces the actual available capacity of the battery over time.

Final Discharge Voltages

The battery cut-off voltage is the volts per cell to which a battery may be discharged safely to maximize battery life, this value is specified according to the actual discharge load and run time.

Discharge Current	Cut Off Volts / Cell
0.50 - 1.0 C	1.55
0.20 - 0.5 C	1.70
0.05 - 0.2 C	1.75

Storage – Self-Discharge

- During storage, batteries gradually lose their capacity due to their self-discharge. The self-discharge rate is low and is typically less than 3% per month at 25 °C.
- Although the self-discharge rate is low, specific precautions must be taken against the battery over self-discharging itself when in storage or not in use.

Charging - CV and CC

There are two common methods of charging a battery.

Constant Voltage (CV) - Voltage of the current source is raised above the voltage of the battery causing the battery to accept current until its voltage matches the voltage of the current source.

- CV is most commonly used to maintain (Float Charge) UPS batteries at 100% State of Charge (SoC)

Constant Current (CC) - Current is forced into the battery causing the voltage to rise.

- CC charging must be monitored and controlled, otherwise a battery can be easily overcharged and a dangerous situation created (battery fire or explosion).

CHARGE METHOD	CYCLIC OPERATION	FLOAT OPERATION	BOOST OR EQUALIZATION
Constant Voltage	2.40 – 2.45 Vpc 0.3 C or less	2.25 – 2.3 Vpc 0.3 C or less	2.40 – 2.45 Vpc 0.3 C or less
Constant Current	0.1C*	N/A	0.1C

*Time limit recommended otherwise overcharge can occur

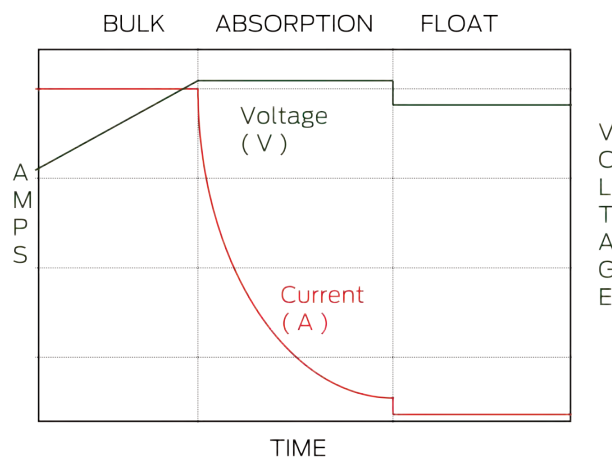
Multi-Stage Charging – CC CV

Multi-stage charging combines CC and CV to deliver the fastest recharge time.

Bulk Stage - Replaces 70-80% of the battery’s capacity at the fastest possible rate. (CC)

Absorption Stage - Replenishes remaining 20-30% of battery capacity (CV).

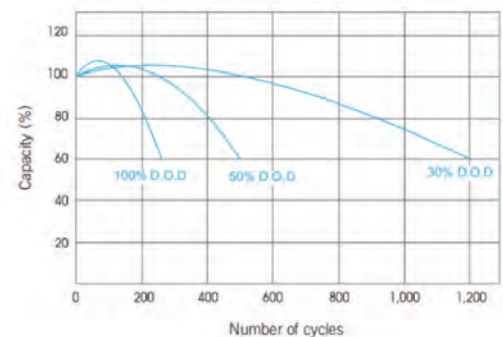
Float Stage - Charger voltage is held constant (CV). Replaces self-discharge and powers other DC loads connected to the battery.



Battery Life

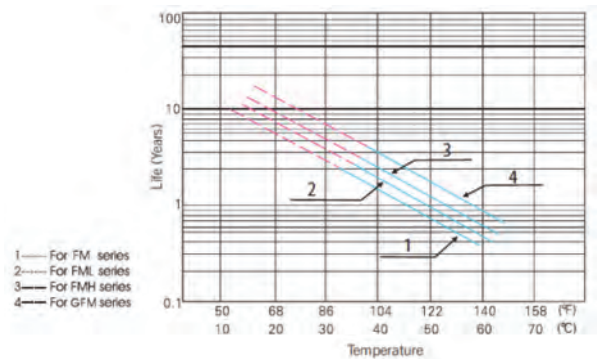
Cyclic Use

- Cycle life is very dependent on the depth of discharge which the battery experiences during each cycle.
- The number of cycles relating to the depth of discharge is shown in the graph.



Floating Use

- Float use life is very dependent on the temperature at which the battery is float charged.
- The float life is very long at low temperature (10~20 °C) but at higher temperature the float life is shortened.



Factors Affecting Lead Acid Battery Life and Performance

- Charging at high or low voltage
- Low or excessive charge current
- High or low temperatures
- Constant overcharging or undercharging
- Loose interconnections between batteries
- Improper maintenance

Lead acid batteries lose capacity (runtime) based on age, cycle usage and operating temperature.

- Every time a battery is discharge, it shortens the remaining lifetime.
- Typically lead acid batteries start to lose capacity and fail within 3 - 5 years.
- Discharging and charging (cycling) of a lead acid battery is an electrochemical process that ultimately results in the destruction of the lead plates (shedding) and the degradation of the electrolyte liquid.
- A high battery cell temperature indicates severe internal issues and that battery replacement is required.

UPS Battery Systems - Key Features

Charging

- The current of the battery charger (Amps) determines how fast the battery can be recharged.
- A multi-stage charger is faster and safer than a constant current (CC) charger.
- Three-stage or multi-stage charging is considered superior to trickle or float charging (CV).
- A temperature sensor improves the quality of charging and maximizes the life time of batteries.

Capacity Test

- UPS will often provide an automated load test which estimates runtime (capacity).
- The estimated runtime is notoriously unreliable due to the nature of batteries which utilize an electrochemical process.

Hot Swappable

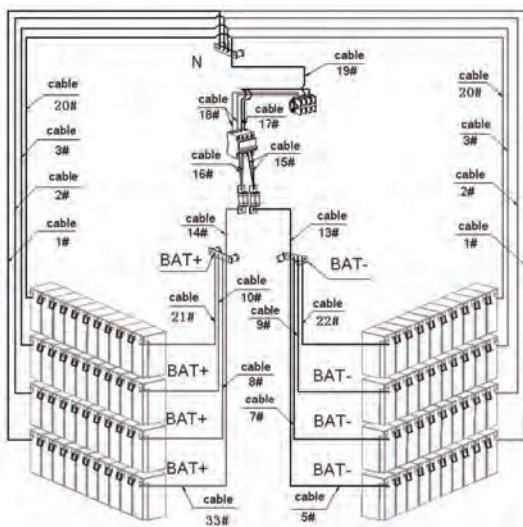
- The ability to change a battery module without taking the critical load off the UPS.

Many UPS battery systems employ a plus/minus (+/-) DC voltage system

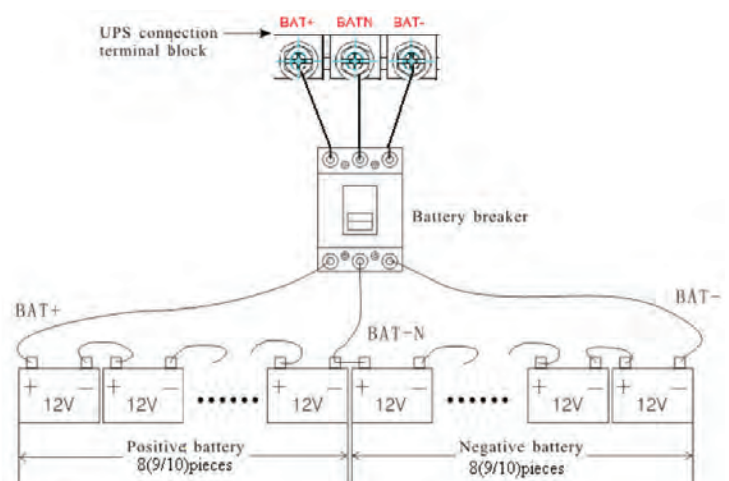
- The Neutral cable, the battery Positive and the battery Negative are all connected to the UPS.
- A neutral cable is attached between the positive and negative connections of the batteries in the middle of the string.
- The +/- voltage of the UPS determines the number of batteries in a string.
- Users can choose the capacity Ah of the batteries used, but all must be of the same type and Ah.

Example +/- 120 Vdc system with 80 batteries total providing 36 Ah of total capacity

- Four 'strings' are configured in parallel, each string has 20 x 9 Ah batteries in series.



+/- 120 Vdc system with 80 batteries



General +/- Vdc Configuration

UPS Battery Systems – Design Considerations

Battery Voltage

The number of batteries required to deliver the +/- is a key system cost driver!

- The +/- voltage of the UPS determines the number of batteries in a string

Example: +/-144Vdc (24 x 12V batteries) vs. +/-204Vdc (34 x 12V batteries)

Battery Runtime

The number and the size (Ah) of batteries required to deliver runtime is a key system cost driver!

- Battery runtime is based on the level of kVA required over a defined period of time without mains support.
- High kVA output and long periods of independence from mains require larger quantities of batteries.
- Battery configurations should be determined by professional design engineers.

Battery System for UPS in Parallel

The number of battery systems is a key system cost driver!

- Some UPS in parallel can share a 'single common battery' others must use a separate battery for each UPS
- Example: Four UPS in parallel using one common battery system vs. four independent battery systems.

Battery Cabinets

- Most UPS above 30kVA require the use of external battery cabinets.
- Ensure that Battery Cabinet costs include: cables to UPS, breakers, fuses, battery interconnect cables.

UPS Battery Systems – Maintenance Considerations

'UPS runtime can be greatly reduced by a single degraded battery that adversely affects the performance of the entire system'

- Battery state-of-health 'testing'
- Discharge testing
- Temperature checks
- Inspection for leaks and corrosion
- Clean and tighten connections



- *UPS availability and performance improves when its supported by healthy batteries*

- *Costly emergency repairs and lost business revenue are avoided when batteries are proactively replaced before a failure*

Battery FAQ

What is the “end of useful life”?

- The IEEE defines end of useful life for a UPS battery as being the point when it can no longer supply 80 per cent of its rated capacity in ampere-hours - the battery should be replaced.
- As batteries sit unused, without being charged, their useful life will decrease. Due to the self-discharge characteristics of lead acid batteries, it is imperative that they be charged every six to 10 months.

Is there any difference between the batteries used by smaller UPS and the ones used by larger UPS?

- Smaller UPS typically use maintenance free Battery Packs. Multiple Battery Packs are connected in parallel to extend run times.
- Larger systems require multiple strings of batteries and battery racks or cabinets which require space and increase overall costs. They also introduce the requirement for battery maintenance.
- Large battery systems should be monitored to prevent a single bad battery from taking down the entire system.

What is the difference between hot-swappable and user-replaceable batteries?

- Hot-swappable batteries can be changed out while the UPS is running by the user and require no special tools or training to replace.

How is battery runtime affected if I reduce the load on the UPS?

- Runtime will increase if the load is reduced.
- General rule: Reduce the load by half, triple the runtime.

If I add more batteries to a UPS can I add more load?

- Adding more batteries to a UPS will increase the battery runtime. However, adding more batteries does not increase the capacity of the UPS to run larger kVA loads.

What is the average lifespan of UPS batteries?

- The standard lifespan for VRLA batteries is three to five years. However, expected life can vary greatly due to environmental conditions, number of discharge cycles, and maintenance.

How can you be sure UPS batteries are in good condition?

- UPS include automatic battery testing which can test for holdup and estimate runtime capacity.
- Battery monitoring systems are available to monitor battery condition and provide advance warning regarding the end of battery life upon detection of a weak battery.
- Large battery systems should be professionally inspected and maintained.

How long does it take for the UPS batteries to recharge?

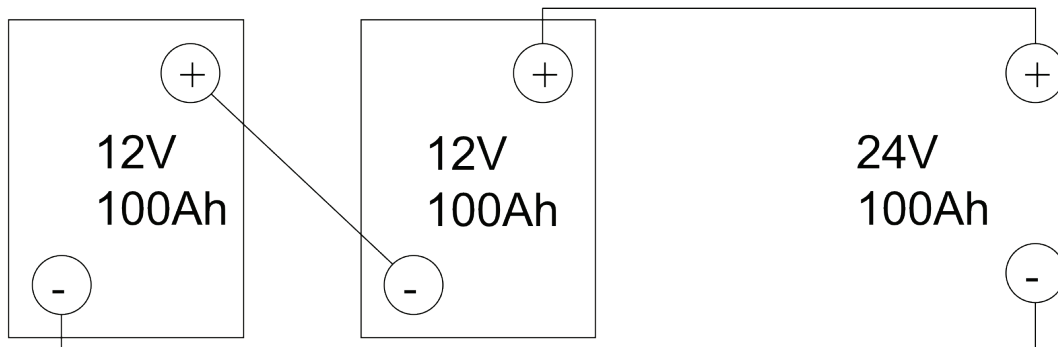
- It can take 10 times the discharge time for the UPS batteries to recharge. (A 30-minute battery discharge can require about 300 minutes to recharge.) UPS with high rate chargers are available.
- After each power outage, the recharge process begins immediately. It is important to note that the load is fully protected while the batteries are recharging. However, if the batteries are needed during the recharge time, the holdup and runtime available will be less than it would have been if the batteries were fully charged.

Battery FAQ

Series - Increases Voltage

Two batteries in series will double the output voltage

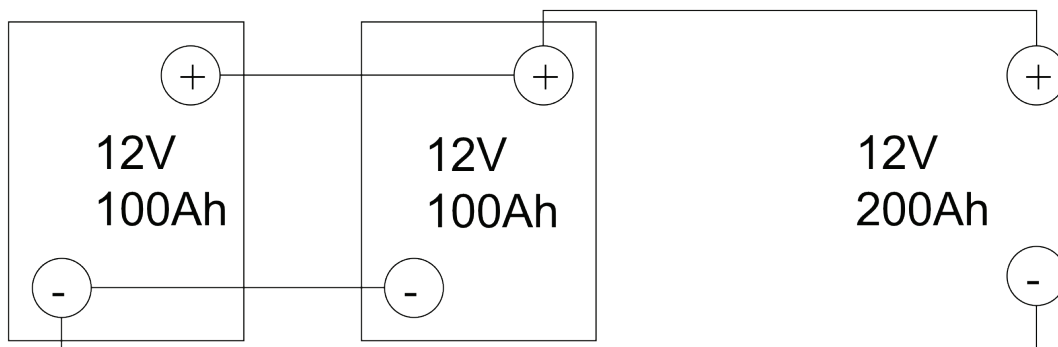
*Cross-connect the bank



Parallel - Increases Amp-Hour Capacity

Two batteries in parallel will double the Amp-Hour rating of the battery bank while the voltage will be the same as each individual battery.

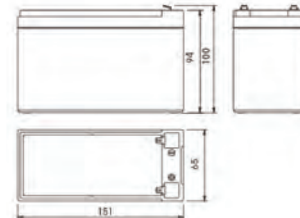
*Cross-connect the bank



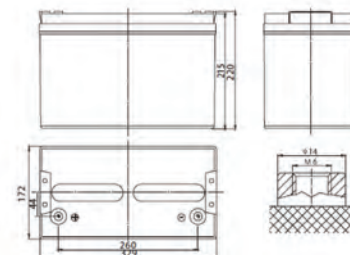
Keatec Sealed VRLA and AGM Batteries

Valve regulated lead acid VRLA and Absorbed Glass Matt AGM batteries are rechargeable and designed for safe, trouble free operation in any position. They can be shipped by sea, road or air without special handling or packaging precautions due to their sealed construction. VRLA and AGM batteries are maintenance free, there is no need to check the specific gravity of the electrolyte, refill electrolyte, or add water during normal operation.

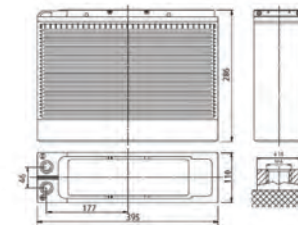
FM Series – Regular 12V (7Ah, 9Ah)



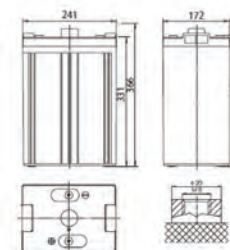
FM Series – Regular 12V
 FML Series – High Cycle 12V
 Solar Series – Deep Cycle 12V



FMH Series – Front Terminal 12V



GFM Series – 2V



NiCd Battery - General Characteristics

Nominal 1.2 Vdc and rated Ah is at C 5 discharge 20 °C (± 5 °C)

- M - Designed for Medium discharge rate of 0.5 It A ~ 3.5 It A
- L - Designed for a discharge rate lower than 0.5 It A

State-of-the-art automated manufacturing ensures consistency and reliability.

NiCd batteries have a service life much longer than that of Lead Acid batteries, which suffer from lead plate shedding and internal corrosion.

NiCd batteries are widely used for outdoor applications because they operate reliably at temperatures up to +60 °C.



NiCd Battery - Pocket Type

Reliable operation at high temperatures

- Designed for -40 to +60 °C operation

Service life can exceed 20 years with virtually no internal corrosion

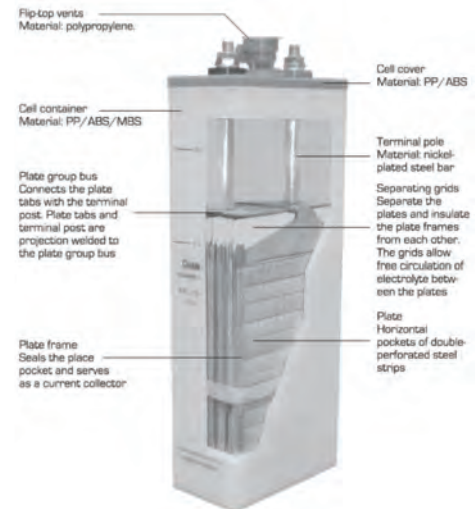
- Pocket plates and internal frames made of steel do not react with the electrolyte and remain intact

Top Quality Materials

- Plates - horizontal pockets of double perforated steel strips
- Separator is polypropylene fiber
- Nickel plated steel terminals
- Translucent plastic container

Easy Handling

- Top access terminals
- Flip top vent caps



Series	Voltage	C5 Rated Capacity	Discharge Rate
KPM	1.2	10 – 1100 Ah	Medium
KPL	1.2	10 – 1200 Ah	Low

NiCd Battery - Gas Recombination Type

Reliable operation at high temperatures

- Designed for -40 to +60 °C operation

Service life can exceed 25 years with virtually no internal corrosion

- Pocket plates and internal frames made of steel do not react with the electrolyte and remain intact

2,000 cycles with at most a single replacement of electrolyte

- Ultra-low water consumption due to high gas recombination efficiency and vent plug technology

Top Quality Materials

- Plates - horizontal pockets of double perforated steel strips
- Separator is polypropylene fiber
- Nickel plated steel terminals
- Translucent plastic container

Easy Handling

- Maintenance free
- Top access terminals
- Flip top vent caps



Series	Voltage	C5 Rated Capacity	Discharge Rate
KGM	1.2	30 – 600 Ah	Medium
KGL	1.2	30 – 600 Ah	Low

Why Use a Lithium-ion Battery?

Lithium-ion (Lion) batteries deliver high power density, deep cycling capability and a service life much longer than that of Lead Acid batteries.

Lion batteries also accept high charge currents and recharge very quickly.

Unlike Lead Acid Batteries, Lion Battery packs precisely control the charging process through an on-board Battery Management System (BMS) that communicates with the charging device.

Lion batteries are maintenance free and ultimately deliver the lowest total cost of ownership.

Lion can be used for outdoor applications because they discharge reliably at temperatures up to +55 °C and can be recharged at temperatures up to +40 °C.

State-of-the-art automated manufacturing ensures consistency and reliability.

Maintenance free rack mounted Lion rechargeable batteries are ideal for Telecom applications.



Lithium-ion Battery - Rack Mount for Telecom

Lifetime of up to 15 years, or 6,000 cycles 80% SoC

Battery Management System (BMS)

- State of charge and health management
- PC management and monitoring software
- RS232 and RS485 communication
- Data storage
- Alarms



Operation at Extreme Temperatures

- Charging 0 to +40°C
- Discharging -20 to +55 °C

Easy Handling

- Rack mount - 19 inch
- Height - 5U
- Parallel up to 15 batteries

Optional

- LCD display screen

Keatec LBT 4850 - 50 Ah 48 Vdc

Keatec LBT 48100 - 100 Ah 48Vdc

Model	LBT 4850	LBT 48100
Nominal	51.2 Vdc	51.2 Vdc
Capacity	50 Ah	100 Ah / 5.12 kWh
Standard Charge & Discharge Current	10 A	20 A
Max Charge & Discharge Current	50A	50 A
H x W x D mm	132.5 x 480 x 383.2	221.5 x 480 x 385
Weight	27 kg	51 kg
Environment	IP 30	IP 30
Standards	IEC 62619, IEC 21A/556CD, RoHS, UN/DOT 38.3, EN 61000-6-1, EN 61000-6-3, EN 55032, EN55024	

Why Keatec Energy? - We Bring the Energy

We design, manufacture, service and install DC and AC uninterruptible power solutions for Telecommunication, Commercial Information Technology (IT), Public Safety and Industrial clients. Keatec Energy is headquartered in British Columbia, Canada, with operations in Mexico serving customers across the Americas.

Services

- Critical Power Solutions
- Startup and Commissioning
- Preventative Maintenance - Batteries / UPS
- System Capacity and Performance Audit - UPS



Why Pay More?

- Great Pricing
- Great Warranty
- Compact Solutions
- Advanced Technology



Exceptional Service

- Solutions and proposals are usually delivered within 48 hours.
- We are local for quick delivery, startup and commissioning.
- Customer support and service 365 days a year.
- Maintenance services and replacement batteries.



Reliable Products

- Quality products
- Proven solutions
- Easy to use



Sales Office and Showroom - Mexico

Oficina A-407, Laguna de términos 221,
Col Granada, Ciudad de Mexico,
CP 11460 Mexico
Teléfono (+52) 55 7258 03



Keatec RT Series UPS 1 - 3 kVA 120 Vac 1PH with Battery

RT Series UPS provides instant backup power for critical commercial equipment and clean power for sensitive loads in a compact design that is easy to use and is a plug and play installation.

- Light weight, rack mount or tower.
- Built-in battery, more than 4 minutes of operating time.
- PC management software included.

Options: RT Series Battery Pack extends backup runtime.



Keatec RT Series UPS 6-10 kVA 208/240/230/220 Vac 2PH

RT Series UPS provides instant backup power for critical commercial equipment and clean energy for sensitive loads in a compact design. The available output transformer provides 120 Vac outlets for loads.

- Light weight, rack mount or tower.
- PC management software included.

Options: RT Series Battery Pack. RT Series 120 Vac Output Transformer.



Keatec T Series UPS 10-15-20 kVA 208 Vac 3PH with Battery

T Series UPS has the smallest footprint and the lowest weight on the market in a mini-tower design with integrated batteries. The T Series also has the highest output power factor, the highest efficiency and the widest AC input range on the market.

- Built-in battery, more than 4.5 minutes of operating time.
- Color screen with real-time energy diagrams.
- PC management software included.

Options: T Series Battery Tower extends backup time.



Keatec C Series UPS 30 - 260 kVA 208 Vac 3PH

C Series UPS has one of the smallest footprints and lowest weights for a cabinet design. The C Series has a high output power factor, high efficiency and the widest AC input range on the market.

- Dual input: static and manual bypass (maintenance).
- Redundant parallel operation of up to 4 units.
- PC management software included.

Options: External battery cabinet.



Keatec M Series UPS 208 Vac 3PH

M Series modular UPS system has the latest technology, including Eco Mode, which offers additional energy savings. The M Series has a high output power factor, high efficiency and the widest AC input range on the market.

- 20kVA hot swap power module with 10A charger.
- M Series Cabinet frames: 100 kVA, 160 kVA, 260 kVA.
- Redundant parallel operation (4x) with synchronized transfer to 'bypass'
- Dual input: static and manual bypass (maintenance).
- PC management software included.

Options: External battery cabinet.



VRLA and AGM Batteries

Keatec Energy

We design, manufacture, service and install DC and AC uninterruptible power solutions for Telecommunication, Commercial Information Technology (IT), Public Safety and Industrial clients.

Keatec Energy is headquartered in British Columbia, Canada, with operations in Mexico serving customers across the Americas.

Services

Integration of Power Solutions
Startup and Commissioning
Preventative Maintenance – Batteries
Preventative Maintenance – UPS
System Capacity and Performance Audit – UPS

Headquarters

Surrey, B.C. CANADA

Telephone

+1 844 307 7998

Sales and Showroom - Mexico & Latin America

Oficina A-407, Laguna de términos 221,
Col Granada, Ciudad de Mexico,
CP 11460 Mexico

Telephone

(+52) 55 7258 0352

