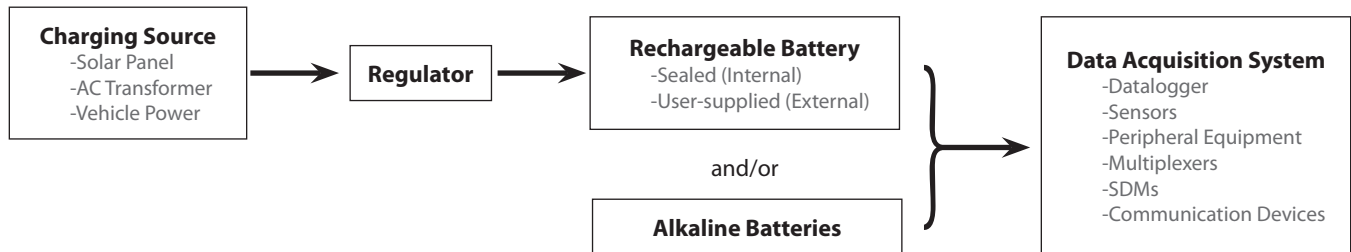


Power Supplies Overview

Batteries, Regulators, Charging Sources



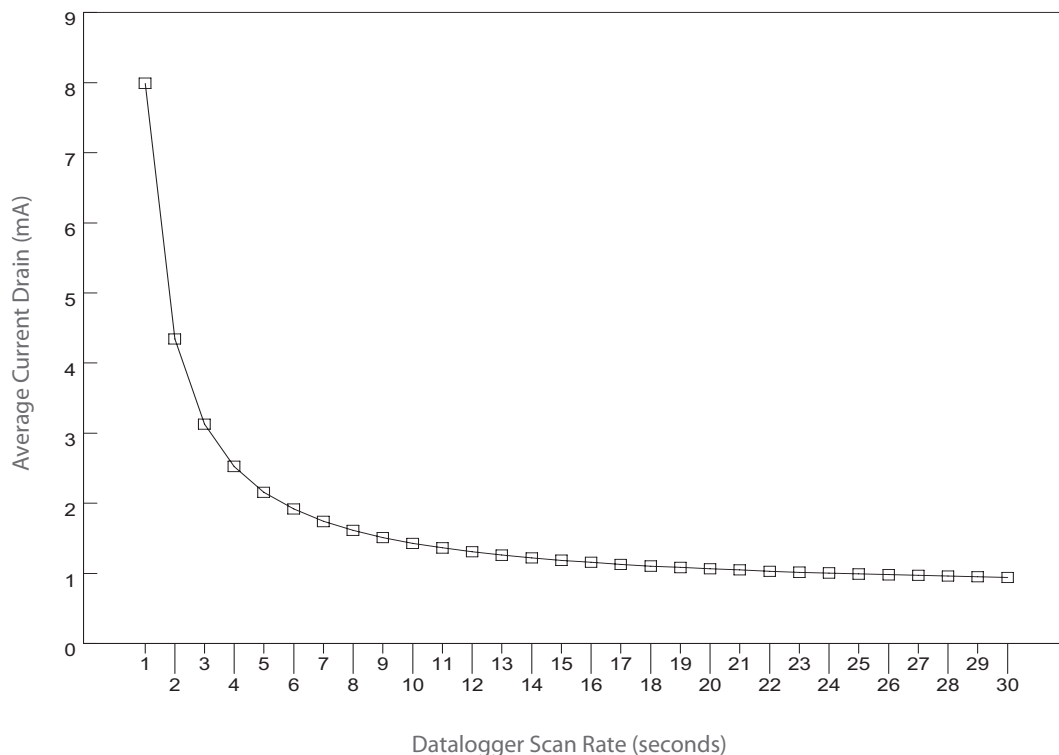
Introduction

Campbell Scientific's data acquisition systems are powered by reliable, inexpensive 12 Vdc sources.¹ Power consumption by our dataloggers, peripherals, and sensors is minimal, allowing extended operation from our standard sealed rechargeable battery or set of alkaline cells. Systems that require more power can be supplemented with external rechargeable batteries, regulators, and charging sources (ac transformer, solar panels). The diagram above depicts the interaction of the components in a power supply system.

Calculating Power Consumption

The system's power consumption can be approximated by calculating the average current required by the datalogger, sensors, and peripheral equipment (multiplexers, SDMs, and communication devices). This average current drain is primarily determined by the percentage of time spent in an active versus quiescent state, which can be approximated from the datalogger's scan rate (Execution Interval) and the program length. Please note that short scan rates dramatically affect average current drain (see graph below).

Current Drain of Typical Weather Station



¹This brochure briefly describes the equipment available to power Campbell Scientific data acquisition systems. For specifications, refer to the brochures of the specific products. Detailed information about calculating power usage is included in our Power Supply Application Note. Product brochures and application notes are available from: www.campbellsci.com

Example Calculation

In applications where the scan rate is in excess of 30 seconds, the datalogger's average current drain approaches the quiescent drain. For example, a CR1000-based weather station measuring standard meteorological sensors at a thirty second (30 s) scan rate has an average current drain of:

State	Duration (seconds)	Current Drain (mA)
Active	0.2	10
Quiescent	29.8	0.6

$$\begin{aligned}\text{CR1000 Average Current Drain} &= \frac{(0.2 \text{ s})(10 \text{ mA}) + (29.8 \text{ s})(0.6 \text{ mA})}{30 \text{ s}} \\ &= 0.66 \text{ mA}\end{aligned}$$

Communication with the station for data retrieval, monitoring, or program transfer also consumes power as the datalogger goes into a processing state, and activates the communication device. To conserve power, Campbell Scientific's modem devices are active only during communication.

For example, if the station is called once a day (1440 min) for 5 minutes via telephone (COM220 modem), the current drain is:

State	Duration (minutes)	Current Drain (mA)
Active	5	30 (COM220) + 10 (CR1000) = 40
Quiescent	1435	0.012

$$\begin{aligned}\text{Current Drain} &= \frac{(5 \text{ min})(40 \text{ mA}) + (1435 \text{ min})(0.012 \text{ mA})}{1440 \text{ min.}} \\ &= 0.15 \text{ mA}\end{aligned}$$

Assuming negligible power consumption by the meteorological sensors, the system's average current drain is:

$$0.66 \text{ mA} + 0.15 \text{ mA} = 0.81 \text{ mA or } 0.00081 \text{ A}$$

Alkaline 12 Vdc Batteries

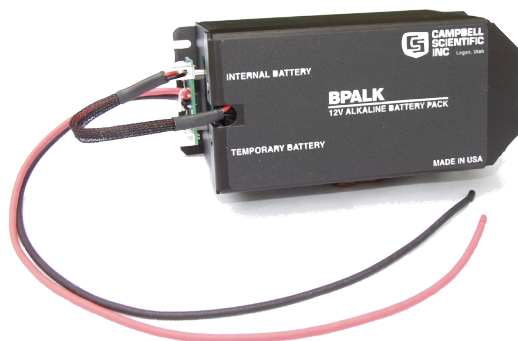
The availability of alkaline batteries makes them attractive for short-term applications where the batteries can be replaced quickly and easily.

The BPALK is an alkaline battery pack that can power a CR800, CR850, or CR1000 datalogger. It contains eight D cells that provide a nominal rating of 7.5 Ah.

The CR3000 datalogger can have an alkaline battery base as part of its integrated package. A CR3000 with this battery base is powered by 10 D cells that provide a nominal rating of 10 Ah.

An alkaline power supply option is not available for our CR200X-series, CR5000, and CR9000X(C) dataloggers. They use either sealed rechargeable batteries or ac power.

Alkaline batteries are not rechargeable, and their Amp hour ratings decrease with temperature extremes. Alkaline batteries may leak when used outside the temperature range of -25° to +50°C, or when the battery voltage drops below 9.6 V.



The BPALK Alkaline Battery Pack includes eight D cell batteries for powering a CR800, CR850, or CR1000 datalogger.

For the above weather station with a system current drain of 0.00081 A, the alkaline batteries theoretically last:

$$7.5 \text{ Ah} / 0.00081 \text{ A} = 9259 \text{ hrs or about } 385 \text{ days}$$

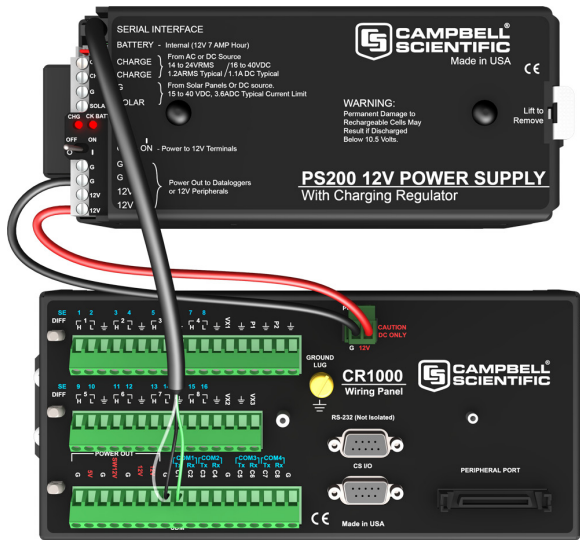
In practice, we suggest monitoring battery voltage to determine actual replacement time.

Rechargeable 12 Vdc Power Supplies

All of our dataloggers can be powered by a rechargeable power supply that consists of a rechargeable battery, regulator, and charging source (typically an ac wall charger or solar panel). The charging source powers the system while float-charging the batteries. The batteries then provide back-up power if the charging source is interrupted.

Sealed Rechargeable Batteries

The PS100² and PS200 are rechargeable power supplies for our CR800, CR850, and CR1000 dataloggers. They consist of a regulator and a sealed rechargeable battery that has a nominal rating of 7.0 Ah. The PS100 is for standard applications.



The PS200 and CH200 have two input terminals that allow simultaneous connection of two charging sources. A maximum power point tracking algorithm for solar inputs is included that maximizes available solar charging resources.

The PS200 is a micro-controller-based smart power supply. It features two-step constant voltage charging and temperature compensation that optimize battery charging and increases the battery's life. Onboard measurements, along with a serial communication interface, provide users with charge input voltage, battery voltage, onboard temperature, battery current, and load current measurements. These measured parameters can be used to compute net charging currents, battery health, and power budgets for improved site management.

Our CR3000, CR5000, and CR9000X(C) dataloggers can have a rechargeable battery base as part of their integrated package. The nominal ratings of their batteries are 14 Ah for the CR9000X, and 7.0 Ah for the CR3000, CR5000, and CR9000XC.

The BP12, BP24, and BP84 are battery packs for powering systems³ that have higher current drain equipment such as satellite transmitters. They consist of a rechargeable battery, enclosure mounting bracket, and cables. A regulator is required (see *Regulators* section).

The PS24 and PS84 are ideal if the power supply will be housed in a separate enclosure. The PS24 consists of a 24-Ah battery, CH100 regulator, enclosure mounting bracket, and a 10-in. x 12-in. enclosure. The PS84 consists of an 84-Ah battery, enclosure mounting bracket, a 14-in. x 16-in. enclosure, and typically the #18529 regulator.

Regulators

Regulators control the current flowing to the battery and prevent the battery current from flowing to the charging source. An internal regulator is included with our PS100 and PS200 power supplies; SP10R and SP20R solar panels; and the rechargeable battery base of our CR3000, CR5000, and CR9000X(C) dataloggers.

A stand-alone regulator must be used with our BP12, BP24, and BP84 battery packs as well as our SP85 solar panel. The BP12 and BP24 battery packs can use either a CH100² or CH200 regulator. The CH100 regulator is for standard applications, and the CH200 is a micro-controller-based smart regulator that has the same features as the PS200 power supply (see first column).



The SP85 solar panel can use either the CH200 or 18529 regulator. The BP84 battery pack uses the 18529 regulator.

Above is a top view of a CH200 showing its LEDs and terminals.

Charging Source—Vehicle Power

Vehicle power can recharge the CR3000 or CR5000's sealed rechargeable batteries if the DCDC18R Boost Regulator is used. Our DCDC18R increases the vehicle's supply voltage (11 to 16 Vdc) to charging levels required by the datalogger base (18 Vdc).



The DCDC18R's case can be conveniently attached to the side of the datalogger, adjacent to its charger input.

²The maximum charging current of the PS100 and CH100 is 1.2 A, which means that the largest solar panel that can be used with them is an SP20.

³The current drain of some systems may require ac power or a user-supplied deep-cycle RV battery.

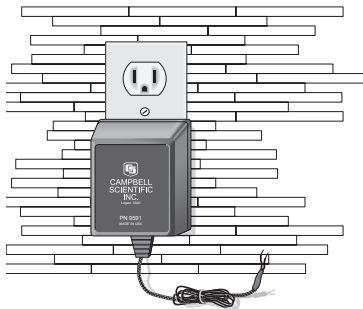
Charging Source—Solar Panels

Solar panels charge batteries by converting sunlight into direct current. Campbell Scientific's SP10 10-W and SP20 20-W solar panels can recharge the battery of a PS100, PS200, BP12 (requires CH100 or CH200), BP24 (requires CH100 or CH200), CR3000, CR5000, or CR9000X(C). The SP10R 10-W and SP20R 20-W solar panels include an internal regulator, and are intended for recharging a user-supplied, deep-cycle RV battery.

The SP85-L 85-W solar panel is used in CO₂ Bowen Ratio, CO₂ Eddy Covariance, or other systems that require high-power solar panels. This solar panel needs to be connected to either a CH200 regulator or 18529 Morningstar SunSaver regulator. Two SP85-L solar panels can be connected to one 18529 regulator to provide 170 W of power.

Charging Source—AC Wall Chargers⁴

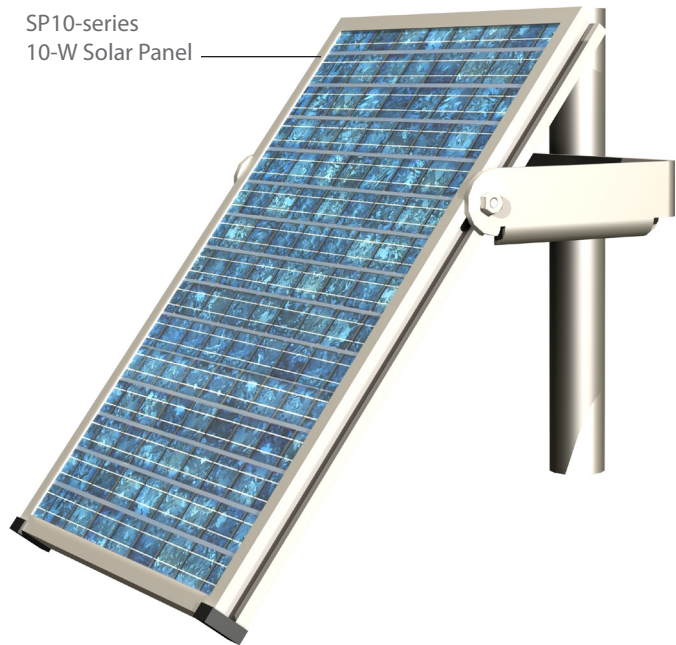
Charging circuitry and ac transformers charge sealed rechargeable batteries by using power from external ac power lines. Hardware for charging the batteries via ac power is included with the CR9000X(C) datalogger.



One end of the #9591 transformer plugs into a wall ac outlet while the other end connects to the power supply, or the battery base of a CR3000 or CR5000 datalogger.

The 9591, 22110, 14014, and 22111 ac transformers are offered for our other sealed rechargeable batteries. The 9591 and 22110 transformers may be used in the United States and in other countries where the ac outlet sources 110 Vac. The 9591 connects directly to a regulator's terminals; the 22110 is fitted with a connector for attachment to a prewired enclosure.

The #14014 and 22111 are generally used when local ac power is provided at voltages other than 110 Vac; they accept ac power in the range of 90 to 264 Vac @ 47 to 63 Hz. The 14014 connects directly to a regulator's terminals; the 22111 is fitted with a connector for attachment to a prewired enclosure.



Solar panels are convenient charging sources for applications where ac power is not available, unreliable, or expensive.

Power Supply Adapters

Campbell Scientific offers two adapters that fasten onto our PS100, PS200, CH100, and CH200. The A100 is for powering peripherals and external devices at non-datalogger sites such as repeater stations. When the A100 adapter is connected a power supply, it can source both 5 Vdc and 12 Vdc. When used with a CH100 or CH200 regulator, either a BP12 or BP24 battery pack is also required at the non-datalogger site.



The A105 adapter adds four 12 V terminals and four ground terminals to the PS100, PS200, CH100, or CH200. The extra terminals make it easier to wire multiple continuously powered 12 Vdc devices to the power supply. The A100 and A105 cannot be used at the same time.



⁴Only the wall chargers used with the datalogger power supply are discussed in this document. Wall chargers for other devices are discussed in the brochure of those devices.