State Of Charge (SOC)

State of charge (SOC), or conversely, the depth of discharge (DOD) can be determined by measuring the voltage and/or the specific gravity of the acid with a hydrometer. This will NOT tell you how good (capacity in AH) the battery condition is - only a sustained *Load Test* can do that.

Voltage on a fully charged battery will read 2.12 to 2.15 volts per cell, or 12.7 volts for a 12 volt battery. At 50% the reading will be 2.03 VPC (Volts Per Cell), and at 0% will be 1.75 VPC or less.

Specific gravity will be about 1.265 for a fully charged cell, and 1.13 or less for a totally discharged cell.

Many batteries are sealed, and hydrometer reading cannot be taken, so you must rely on voltage measurement.

Hydrometer readings may not tell the whole story, as it takes a while for the acid to get mixed up in wet cells.

If measured right after charging, you might see 1.27 at the top of the cell, even though it is much less at the bottom. This does not apply to gelled or AGM batteries.

Measuring the State Of Charge (SOC)

If the battery's electrolyte is above 110° F (43.3° C), allow it to cool down.

To determine the battery's state-of-charge with the battery's electrolyte temperature at 80° F (26.7° C), use the following table below.

The table assumes that a 1.265 specific gravity reading is for a fully charged, Wet Cell, Lead Acid battery.
For other electrolyte temperatures, use the Temperature Compensation table below to adjust the Open Circuit Voltage or Specific Gravity readings.

The Open Circuit Voltage will vary for GEL Cell and AGM type batteries, so check the manufacturer's specifications.

Digital Voltmeter Open Circuit Voltage	Approximate State-of-Charge	Hydrometer Average Cell Specific Gravity	Electrolyte Freeze Point
12.65 V	100%	1.265	-75° F (-59.4° C)
12.45 V	75%	1.225	-55° F (-48.3° C)
12.24 V	50%	1.190	-34° F (-36.7° C)
12.06 V	25%	1.155	-16° F (-26.7° C)
11.89 V	Discharged	1.120	-10° F (-23.3° C)

STATE-OF-CHARGE

[Source: BCI]

Electrolyte Temperature Fahrenheit (°F)	Electrolyte Temperature Celsius (°C)	Add or Subtract to Hydrometer's SG Reading	Add or Subtract to Digital Voltmeter's Reading
160°	71.1°	+.032	+.192 V
150°	65.6°	+.028	+.168 V
140°	60.0°	+.024	+.144 V
130°	54.4°	+.020	+.120 V
120°	48.9°	+.016	+.096 V
110°	43.3°	+.012	+.072 V
100°	37.8°	+.008	+.048 V
90°	32.2°	+.004	+.024 V
80°	**26.7°**	**0**	**0 V**
70°	21.1°	-.004	-.024 V
60°	15.6°	-.008	-.048 V
50°	10°	-.012	-.072 V
40°	4.4°	-.016	-.096 V
30°	-1.1°	-.020	-.120 V
20°	-6.7°	-.024	-.144 V
10°	-12.2°	-.028	-.168 V
0°	-17.8°	-.032	-.192 V

Temperature Compensation

Electrolyte temperature compensation is depending on the battery manufacturer's recommendations and will vary.

When using a non-temperature compensated HYDROMETER, make the adjustments referring to the table above.

For example:

At 30° F (-1.1° C), the specific gravity reading would be (1.265 – 0.020) **1.245** for a 100% State-of-Charge.

At 100° F (37.8° C), the specific gravity would be (1.265 + 0.008) **1.273** for 100% State-of- Charge.

This is why using a temperature compensated hydrometer is highly recommended and more accurate than other means.

If you are using a DIGITAL VOLTMETER, make the adjustments indicated in the table above.

For example:

At 30° F (-1.1° C), the voltage would be (12.65 – 0.120) **12.53 V** for a 100% State-of-Charge.

At 100° F (37.8° C), the voltage would be (12.65 + 0.048) **12.698 V** for 100% State-of-Charge.

For non-sealed batteries, check the specific gravity in each cell with a hydrometer and average the readings.

For sealed batteries, measure the Open Circuit Voltage across the battery terminals with an accurate digital voltmeter. This is the only way you can determine the State-of-Charge (SOC).

Some batteries have a built-in hydrometer, which only measures the State-of-Charge in one of its six cells.

If the built-in indicator is clear or light yellow, then the battery has a low electrolyte level and should be refilled and recharged before proceeding.

If sealed, the battery is toast and should be replaced. If the State-of-Charge is below 75% using either the specific gravity or voltage test or the built-in hydrometer indicates bad (usually dark), then the battery needs to be recharged before proceeding.

You should replace the battery, if one or more of the following conditions occur:

- If there is a .05 (sometimes expressed as 50 points) or more difference in the specific gravity reading between the highest and lowest cell, you have a weak or dead cell(s). If you are really lucky, applying an **EQUALIZING** charge may correct this condition. (See Equalizing Charge – page 26)

- If the battery will not recharge to a 75% or more state-of-charge level or if the built-in hydrometer (LED display) still does not indicate green (which is 65% state-of-charge or better).

- If digital voltmeter result indicates 0 volts, you have an open cell.

- If the digital voltmeter or the battery analyzer's results indicates 10.45 to 10.65 volts, you probably have a shorted cell or a severely discharged battery. A shorted cell is caused by plates touching, sediment (mud) build-up or treeing between the plates.

If you know that a battery has spilled or bubbled over and the electrolyte has been replaced with water, you can replace the old electrolyte with new electrolyte and recharge again.

Battery electrolyte is a mixture of 25% sulfuric acid and distilled water.