

## Balmar Voltage Regulation Technology

High output alternators are an important part of your system for battery care, but they are definitely not the only part. Without proper voltage regulation, battery charging can be a slow process, or even worse, an ideal recipe for early battery failure.

All commercial alternators come with an internal rectifier / regulator circuit that:

- (1) Converts AC current generated by the alternator to DC current, and
- (2) fixes the voltage output to a static level - typically 14.6 volts.

There are several deficiencies with internal regulators:

- (1) Not all battery technologies want to receive 14.6 volts.
- (2) All battery types have an optimal charging "profile", which means they want different voltages and currents at different stages of their charging cycle, as well as variations when battery temperatures change.
- (3) Once fully charged, batteries can overheat if they are supplied with continuous current at a fixed charge voltage.

Balmar's patented Max Charge and ARS-5 Voltage Regulators provide a dynamic method for monitoring battery condition and apply the correct level of alternator control (voltage and current) to ensure that your batteries are charged quickly and safely.

During engine operation, Balmar regulators step through the following stages to ensure proper battery charging:

**Stage 1: Start Delay** - After engine startup, the regulator waits for several seconds before applying field current to the alternator. This allows the engine and belts an opportunity to warm up before the the alternator load is applied.

**Stage 2: Soft Ramp** - The regulator slowly increases field excitation of the alternator to reduce belt stress.



**Stage 3: Bulk Charging** - The regulator increases field output to the maximum safe level, allowing the alternator to reach maximum amperage output based on the target limits of the battery type being charged. Target voltage ranges from 14.1V to 14.6V depending on the battery type selected (24V bulk charging voltages range from 28.2V to 29.2V). Bulk time is a factory set at 18 minutes, and is fully adjustable in advanced programming mode.

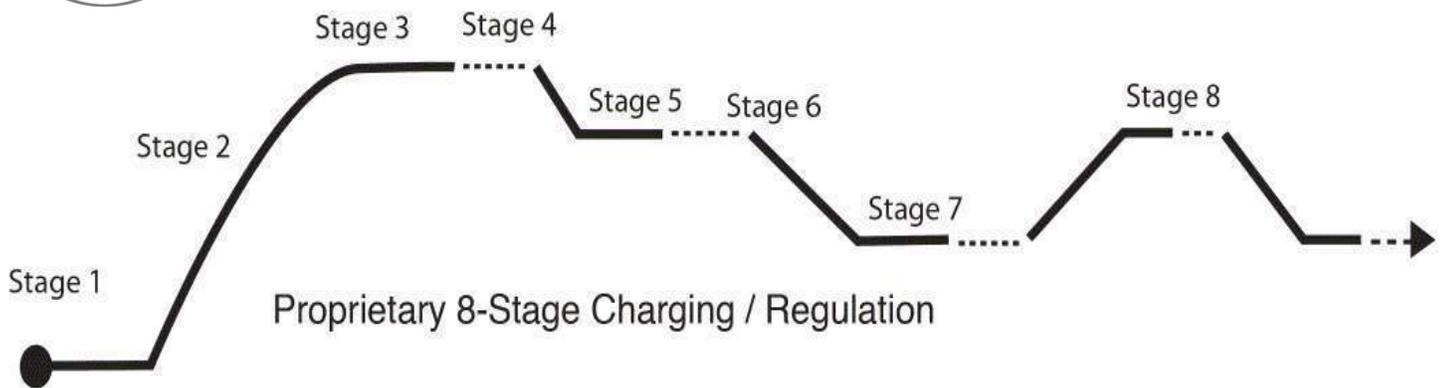
**Stage 4: Calculated Bulk** - At the end of the set bulk time period, the regulator calculates the state of charging based on the alternator's ability to reach and maintain target voltage, and the percentage of field output required to maintain that voltage. This stage will maintain bulk charging until all criteria are met, at which point the regulator will ramp down to absorption voltage.

**Stage 5: Absorption Voltage** - Typically two tenths of a volt below bulk target voltage, absorption voltage allows the alternator to drive current into the almost fully charged batteries without overcharging. Absorption time is preset at 18 min. and is adjustable in the regulator's advanced programming mode.

**Stage 6: Calculated Absorption** - At the end of the set absorption time period, the regulator calculates the state of charging based on the alternator's ability to reach and maintain the target voltage and the percentage of field output required to maintain that voltage. This stage will maintain the absorption charging voltage until all criteria are met, at which point, the regulator will ramp down to float voltage.

**Stage 7: Float Voltage** - Typically one (1) volt below bulk target voltage, float voltage allows the alternator to drive current into fully charged batteries sufficient to replace any battery capacity used while under way. Float time preset is at 18 minutes and is adjustable in the regulator's advanced programming mode.

**Stage 8: Calculated Float** - At the end of the set float time period, the regulator calculates the state of charging based on the alternator's ability to maintain the target float voltage and the percentage of field output required to maintain that voltage. If all the calculation criteria are met, the regulator will continue to maintain float voltage. If the calculation indicates that the alternator is failing to maintain battery voltage, the regulator will return to absorption voltage.



## Balmar Multi-Stage Regulator Additional Features

### User-Selectable Preset Battery Programs

Balmar provides multiple charge profiles to ensure optimal charging. Simply select the battery program that matches your battery technology. The Max Charge regulator family contains 7 preset charge profiles. The ARS-5 contains 5 preset profiles. See the chart below for a listing of battery programs.

### Advanced Programming Modes

Balmar multi-stage regulators feature a broad range of advanced regulator adjustments. By accessing the advanced programming function, the user can modify charging times and voltages in all stages of charge, adjust start delay times, temperature compensation limits, temperature compensation slopes, and modify set points for alternator over-temperature response.

### Alternator and Battery Temperature Sensing and Control

Balmar multi-stage regulators have the ability to automatically correct charging output to ensure that batteries are properly charged regardless of ambient temperature. If battery temperatures exceed safe operating levels, Mac Charge and ARS-5 Voltage Regulators will automatically reduce charging outputs to avoid dangerous thermal runaway conditions.

### Belt Load Management

Balmar multi-stage regulators can protect the engine and belt by enabling the user to de-rate the alternator's output in small increments by adjusting the Belt Load Manager. Adjustable in 5% increment, the Belt Load Manager reduces the regulator's field pulse bandwidth, thereby reducing load on the drive belt. The Belt Load Manager can also be used to protect the alternator in applications where battery capacity exceed ideal charging ratios.