INTRODUCTION

VOLTMAGIC R/C SYSTEM MONITOR – WHAT IT DOES, and what the acronyms (AV, PLV, and OV) mean:

Averaged Voltage (AV) — See Table 1. Shows a steady display of the current voltage. Each LED represents a 0.1 volt step. There are 20 ranges to select from that include: 4-cell Ni, Regulators / BEC, 5-cell Ni, 2-cell A123 (LiFe) and 2-cell Li (7.4). This allows one monitor for all applications, plus you can fine-tune the colored LEDs to match your system, and your personal preference.

- ✓ For batteries (or generator setups that charge batteries), select an **AV** range that will show yellow when the battery is starting to get low. Battery voltage and at-rest amperage will vary, so adjust the range for your setup. When to charge a battery depends on battery characteristics, amperage, flight duration, etc. Using battery load, discharge, or capacity test instruments in addition to VoltMagic is good practice. You can compare with a loaded meter test, or configure for 1 green LED above yellow with about 45% discharge. For the best precision, do this test: You will need a charger that reads out the mAH charged or discharged. First, fully charge the battery and then discharge it to about 45% of capacity using the charger. Now discharge the battery further using the servos until the yellow LED stays on. The most repeatable reading is with the servos at idle but after some load (stirring the sticks). For future reference, take a quick reading with an accurate loaded voltmeter (2 decimal place resolution), then discharge the remaining mAH on the charger and note the mAH reading. If desired, change the AV range of VoltMagic up or down and repeat the test. 15% - 40% of mAH capacity is typically achievable. Repeatability of this test is often + - 2% or less, try it. Also note that cold weather battery temperatures generally result in more mAH remaining in this test, which is desirable.
- ✓ When a battery is fully charged, expect the voltage to go down quick initially. For example, a typical Ni battery may drop from LED 1 to LED 4 on the first flight, but not hit yellow until the end of the fourth flight. Visit the FAQ page at VoltMagic.com for more tips.
- ✓ For voltage regulators, ranges 5 through 9 are ideal -- select a range that displays the regulator output in the green band, but below the highest green LED.

Peak Low Voltage (PLV) — See Table 2. Below a certain threshold, shows the lowest voltage at the receiver (or wherever it's connected). The coarse range of PLV is based on the selected AV range, but you can also fine-adjust with Normal or Low Range PLV. **Extended PLV** is an optional feature that temporarily extends an extra 0.2 volts to the high end of the PLV range for an early look. It's displayed on LED 5 if the switch (or other control VoltMagic is connected to) is toggled quickly 5 times AFTER 1 minute of run time.

- ✓ PLV is letting you know that the instantaneous voltage has dipped lower then usual. PLV is sampled at about 1000 times per second, so it can detect momentary low voltage issues by just stirring the sticks on the ground. This is because when servo motors reverse quickly, they momentarily draw in-flight current. Slow data loggers won't reliably detect this. It's a unique concept to sample fast and log the true minimum voltage if it gets below a threshold. Insufficient or failing batteries, regulators, switches, or connectors will often be detected by low PLV. Naturally, a low battery can trigger PLV blinking, too.
- ✓ Many power-hungry servos make it difficult to keep the PLV from blinking with Normal Range PLV, so **select Low Range PLV if LEDs 5-8 blink under normal conditions**. If LEDs 5-8 still blink with Low Range PLV, please see TROUBLESHOOTING LOW PLV on the INSTALLATION page. Table 2 lists all the different LED trip points that are possible.

  NOTE: For Low Range PLV with the 4-cell or regulator ranges, the first yellow PLV alert is 3.8 volts. This is the same voltage at which some manufacturers initiate their battery failsafe IF a time delay period elapses. Typically the voltage will spike below 3.8 momentarily BEFORE it stays low long enough to initiate the battery failsafe. Absolute minimum voltage requirements vary, and manufacturer's ratings may not include this information. Some airborne equipment may require 3.5 volts (or more), some may tolerate 3.0 volts. The failure mode from momentary undervoltage also varies widely. Notable is the reconnect time for some types of receivers.

Overvoltage (OV) — See Table 2. This only applies to the ranges for Voltage Regulators / BEC. Shows if the regulator failed high, and voltage went above a certain failure threshold. If PLV and OV actually happen on the same flight, only PLV will be displayed.

Glitch and Failsafe Counting — See Table 3. You can select Glitch (for all receiver types) or Failsafe (for receivers with an adjustable failsafe position). The counting is smart, so several within a short time period are counted as the same glitch. Please see the INSTALLATION page for specifics about this selection.

Data Logger — This feature plays back any PLV / OV and Glitch / Failsafe count from the previous flight when the power is turned on.

Reading the LED Display of AV, PLV, and Glitch / Failsafe Count: At least one LED will always be lit showing AV. Normally, that's all you should see. You could have up to three LEDs lit at one time: one showing the AV (any of the LEDs), one blinking to show the PLV or OV (LEDs 5-8), and one blinking the Glitch/Failsafe count (always LED 1). If the AV is lighting up the same LED that the PLV / OV or Glitch counter is blinking, it will blink off quickly rather then blink on. This is the key to understanding the display. Please see the OPERATION page for a diagram.

SPECIFICATIONS

Weight: 7.3 grams Input voltage: 2.8 to 8.5 vdc Calibration: within 0.15 vdc Sample rate: 1000/second Frame Rate: 12-23ms

LIABILITY EXCLUSION AND SAFETY

Never turn off your brain and rely solely on this device. Observe safe practices concerning your particular model. Always perform an appropriate pre-flight check. As manufacturers, we are not in a position to ensure the proper methods of operation when installing, testing, or using this product, nor can we assure the fitness of this product for your particular application. For these reasons, we do not accept any liability for loss, damage, or injury connected with this product. By using VoltMagic, you agree to this.

INSTALLATION

1. **Connect the attached lead**, just like a servo, to the receiver. (Wire colors: brown is equivalent to black, and orange is equivalent to white.) A "Y" harness may be used if there is not a spare channel on the receiver. If a "Y" harness is used, connect it to a channel with low current draw. When configuring VoltMagic for failsafe detection on receivers with a failsafe setting, using a separate channel is advised since its failsafe position will be adjusted for VoltMagic. VoltMagic can also be plugged into a socket that does not have a channel signal (such as one for a DSC) or connected directly to a battery (such as a 7.4v LiPo). If VoltMagic is connected without a channel signal, glitch and failsafe counting is disabled and you will have to connect it somewhere with a channel signal temporarily to change the configuration. **CAUTION:** Do not connect to over 8.7 volts—damage may result.

2. **Set Glitch or Failsafe detection:** Decide whether to use Glitch or Failsafe mode, which determines whether you want LED 8 ON or OFF in configuration. Always choose Glitch mode unless you have a receiver with an adjustable failsafe position for the channel VoltMagic is plugged into.

   A **Glitch** is a bad or missing pulse from the receiver. Glitch counting works with all receivers (PPM, PCM, and 2.4 GHz). With PCM and 2.4 GHz, a glitch indicates some type receiver failure (possibly a reboot). With PPM, the glitch count indicates a loss of transmitter signal (or possibly receiver failure). Failsafe counting will only work with receivers that can set a failsafe servo position, for the channel VoltMagic is connected to, when the transmitter signal is lost. In addition to checking for bad or missing pulses, **Failsafe** counting checks if the signal from the receiver is at maximum high or low, which is the failsafe position to set for the channel connected to VoltMagic. The receiver should output this failsafe position signal ONLY when the radio signal is lost, so the transmitter end points (ATV) are left at 85% to keep the normal signal out of the failsafe zone.
   NOTE: For radios with a throttle channel failsafe, insure that it is set to the idle position.

   - **Proceed** to the **CONFIGURATION** page and begin at the top of the configuration flow chart.

   NOTE: In CONFIGURATION mode, the choices are in a loop: after 21, it starts back at 0. You can only select one choice at a time, then save it by turning the power off. So, if you wanted to change everything (AV range, PLV range, and Glitch / Failsafe) it would take three times through, turning power off after each time, to save the selections. It's a good idea to know what LEDs you want lit in advance because after 20 seconds without any activity, the previous configuration is restored and configuration ends. The complete configuration is briefly displayed on power up, at the end of the LED test pattern.

3. **Set the Averaged Voltage range (AV):** Look at TABLE 1 on the CONFIGURATION page and decide what range for AV you would like to initially use. Make a note of which LED(s) must be lit in configuration to choose that range. We suggest using Normal PLV range initially, and then change to Low Range later if LED's 5-8 blink for low PLV in normal use. To enter configuration, your transmitter ATVs for the channel connected to VoltMagic should be about 85% (more is acceptable when not using failsafe detection).
   - **Proceed** to the **CONFIGURATION** page and start at the SET VOLTAGE RANGES block.

4. **Test Glitch or Failsafe detection:** Skip this test for Glitch mode with 2.4 GHz, PCM, or similar receivers. To test a failure of the transmitter-to-receiver link, turn on the transmitter and receiver for **longer than one minute** to enable glitch (or failsafe) counting. Now turn the transmitter off and back on. Green LED 1 should blink (see the OPERATION page). If failsafe detection doesn't work at first, try setting the failsafe again to the opposite extreme.

5. See the **OPERATION** page for specifics on reading the LEDs.

TROUBLESHOOTING LOW PLV

For non-regulated systems, plug the battery directly into the receiver and then stir the sticks quickly. Servos draw in-flight load current with a sudden reversal, but only for a short duration. Slower devices will miss these quick voltage dips, but VoltMagic will record them. If the PLV is now significantly better, the resistance of the switch harness and its connectors caused the difference in PLV, and the harness probably isn't suitable for the peak amperage of the servos. If there is still low PLV, the battery and/or its connecter are probably not suited for the peak amperage of the servos (even though the battery may check out fine by itself). Note that it is normal to have yellow or red PLV when a battery is getting low. Cold temperatures can also degrade battery performance, resulting in lower PLV.

Example: A 4-cell 2700 mAH battery and generic HD switch with one 9251 and four 9252 digital servos. The PLV was **3.4 volts**. Substituting a 4-cell Sanyo 1950 HR-4/5FAUP pack, and a Futaba HD switch modified with a PowerPole connector to the battery and twin leads feeding the RX, the PLV is now **4.6 volts**. Both tests were after a full charge followed by a 1200 mAH discharge.

Generally, use whatever keeps the voltage normal, but here are some specific suggestions with digital servos and Ni batteries: Use low impedance batteries (5 mOhms or less). For example, the Sanyo discharge graph for 1950 HR-4/5FAUP cells shows ~1.1 volt per cell at 10 amps, and the weight is only 39 grams. Use a high current switch with two poles (e.g. Futaba's heavy duty switch). Either use a battery with twin leads (or dual batteries) and install two switches both feeding the receiver, **or** replace the connecter between the battery and switch with a Power Pole or Deans type. To further lower voltage drop with a single-switch setup, replace the single output lead of the switch harness with two leads to feed the receiver.

For regulators and all battery setups, you can unplug individual servos and stir the sticks to see the effect of lowering servo load on PLV. Batteries or switch harnesses that are barely capable of handling multiple digital servos are common. R/C connectors from a battery are marginal when they have to feed the current for several digital servos.

With a regulator, low PLV can be caused by the regulator itself, poor connections, excess servo load, or the supply battery (possibly from internal voltage drop, cold temperatures or low charge). The averaged voltage output of a regulator should not change as the supply battery discharges, unless the voltage is below a certain threshold (greater then the output voltage). Despite this, the instantaneous voltage will still vary, especially with sudden load changes. Also note that only regulator failure can cause OV (Over Voltage).

CONFIGURATION

VM2Y-20

www.VoltMagic.com

To **CONFIGURE,** first decide…

…GLITCH

Connect VoltMagic to receiver.

Set transmitter ATVs (end points) to > 85% for channel connected to VoltMagic

…or FAILSAFE (failsafe position RX only)

Connect VoltMagic to unused channel on receiver.

1. Set transmitter ATVs (end points) to maximum (typically 140% for Futaba, 150% for JR) for channel connected to VoltMagic.
2. Set the channel's failsafe position to **full high or low**.
3. Re-set the channel's ATV's to 85%.

SET GLITCH or FAILSAFE MODE:

1. Turn on receiver while continuously toggling the channel connected to VoltMagic back and forth **quickly** during the first 3 seconds after power up, until green LED 1 starts blinking. (It blinks continuously during configuration.)
2. If red LED 8 already indicates the desired mode (it will be off for Glitch or on for Failsafe as you cycle through the voltage range choices), skip to **SET VOLTAGE RANGE, step 2**.
3. Otherwise, toggle the channel slowly to step through the choices. Find the last choice in the cycle (see Table 1). Red LED 8 will toggle off for glitch or on for failsafe using the last saved voltage range choice. If you go past, just keep toggling until the last choice comes around again.
4. Turn power off within 20 seconds to save the Glitch/Failsafe mode selection.

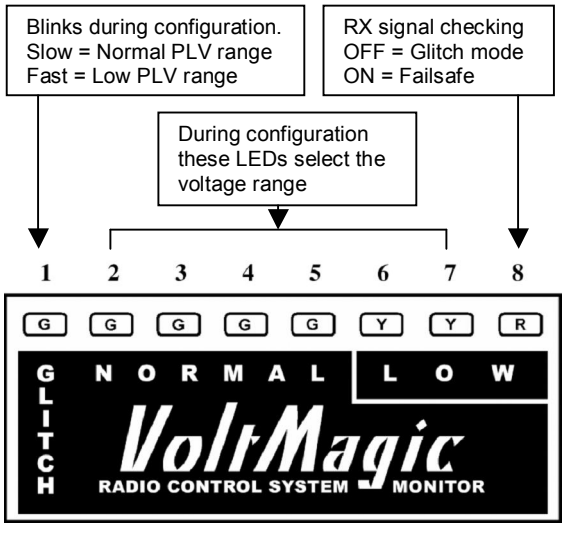
SET VOLTAGE RANGES (repeat twice if changing both the AV and PLV ranges):

1. Turn on receiver while continuously toggling the channel connected to VoltMagic back and forth **quickly** during the first 3 seconds after power up, until green LED 1 starts blinking continuously. LED 1 blinks very fast if PLV is on Low Range.
2. Toggle the channel slowly to step through the choices (see Table 1, below) and stop when the desired LED configuration is reached. The choices will repeat in a loop. PLV Normal or Low Range is the next to last choice, and is set separately from AV.
3. Turn power off within 20 seconds to save the voltage range selection.

TABLE 1: Configuration of Voltage Ranges + Glitch or Failsafe Mode -- In order of appearance during configuration.

✓ Note: The default (range 3) is a conservative four-cell Ni battery choice. Battery voltage and idle current will vary, so adjust for your setup. There are ranges for many different batteries and regulators; please see the INTRODUCTION page for more details.

Voltage Ranges 0.1 Volt per LED Glitch or Failsafe mode is the last choice				**Configuration LED Display**	
#	Averaged Voltage *	PLV range ** Normal	Low		
0	5.30 – 4.60	4.6 – 3.8	4.2 – 3.4	LED's 2-7 OFF	4 cell Ni
1	5.35 – 4.65	4.6 – 3.8	4.2 – 3.4	Green LED 5	4 cell Ni
2	5.40 – 4.70	4.6 – 3.8	4.2 – 3.4	Greed LED 4	4 cell Ni
3	5.45 – 4.75	4.6 – 3.8	4.2 – 3.4	**Green LED 3 (default)**	4 cell Ni
4	5.50 – 4.80	4.6 – 3.8	4.2 – 3.4	Green LED 2	4 cell Ni
5	5.30 – 4.60	4.4 – 3.8	4.0 – 3.4	Green LED 3 **+** Green LED 5	5.2-4.9 reg
6	5.60 – 4.90	4.4 – 3.8	4.0 – 3.4	Green LED 4 **+** Green LED 5	5.5-5.2 reg
7	5.90 – 5.20	4.6 – 4.0	4.2 – 3.6	Green LED 3 **+** Green LED 4	5.8-5.5 reg
8	6.20 – 5.50	4.6 – 4.0	4.2 – 3.6	Green LED 2 **+** Green LED 3	6.1-5.8 reg
9	7.10 – 6.40	5.4 – 4.8	5.0 – 4.4	Green LED 5 **+** Green LED 2	7.0-6.7 reg
10	6.50 – 5.80	5.6 – 4.8	5.2 – 4.4	Yellow LED 6	5 cell Ni
11	6.60 – 5.90	5.6 – 4.8	5.2 – 4.4	Yellow LED 6 **+** Green LED 5	5 cell Ni
12	6.70 – 6.00	5.6 – 4.8	5.2 – 4.4	Yellow LED 6 **+** Green LED 4	5 cell Ni
13	6.88 – 6.18	5.6 – 4.8	5.2 – 4.4	Yellow LED 6 **+** Green LED 3	2 cell A123
14	6.92 – 6.22	5.6 – 4.8	5.2 – 4.4	Yellow LED 6 **+** Green LED 2	2 cell A123
15	6.96 – 6.26	5.6 – 4.8	5.2 – 4.4	Yellow LED 7	2 cell A123
16	7.70 – 7.00	6.6 – 5.8	6.2 – 5.4	Yellow LED 7 **+** Green LED 5	2 cell Li
17	7.80 – 7.10	6.6 – 5.8	6.2 – 5.4	Yellow LED 7 **+** Green LED 4	2 cell Li
18	7.90 – 7.20	6.6 – 5.8	6.2 – 5.4	Yellow LED 7 **+** Green LED 3	2 cell Li
19	8.00 – 7.30	6.6 – 5.8	6.2 – 5.4	Yellow LED 7 **+** Green LED 2	2 cell Li
20	PLV Normal or Low Range			LED 1 **Slow blink** = Normal **/ Fast** = Low	
21	Glitch (PPM) or Failsafe detection			Red LED 8 **OFF** = Glitch **/ ON** = Failsafe	



***** There is a 0.1 volt difference between each LED. Using Range 0 for example, LED8 is 4.60 volts or less, LED7 is 4.70 volts, and yellow LED6 is 4.80 volts. A proprietary algorithm accurately dampens changes.

****** PLV = Peak Low Voltage (including extended PLV). Overvoltage (OV) is included for the regulator ranges. See Table 2 for the specific trigger points.

OPERATION

One of the 8 LEDs is always lit to show Averaged Voltage (**AV**) for the battery or voltage regulator output; see Table 1. One of LEDs 5-8 may blink to record Peak Low Voltage (**PLV**) or OverVoltage (**OV**); see Table 2. LED 1 may blink to count radio glitches; see Table 3. If the same LED blinks that is also lit for AV, it will blink off instead of on. Properly configured, the LEDs show the following:

RED	**AV** extra low	**1 or 2 blinks**	**PLV** very low / extra low
YELLOW	**AV** low (LED 6) or very low (LED 7)	**1 or 2 blinks**	**PLV** low
GREEN LED 5	**AV** normal	**1 or 2 blinks**	**PLV** approaching Yellow (**OV** for ranges 5-8)
GREEN LED 2 - 4	**AV** normal		
Green LED 1	**AV** normal (full battery)	**Blink(s)**	= Glitch (or Failsafe) count

On power up, VoltMagic displays an LED test pattern that ends with a display of the current configuration (see Table 1). Then, if blink warnings (glitches, PLV, OV) were logged from the previous flight, they will display for 10 seconds, after which VoltMagic displays the current readings. Note that glitch (or failsafe) counting is enabled after one minute of operation.

- ✓ Note that if you cycle power within a minute of turning on, you can view the previous flight data again. After one minute of operation, the previous data is erased and current data is recorded.
- ✓ Batteries need some time and load for the voltage to stabilize. Exercise the servos rapidly and check VoltMagic before flying. The most consistent AV reading is after the battery is exercised, with the servos still.

TABLE 2: Peak Low Voltage (PLV) and Overvoltage (OV) -- The specified LED blinks once or twice followed by a pause when voltage falls below the PLV setting; only the lowest voltage is displayed. If averaged voltage (AV) is also being displayed with the same LED, it will blink off instead of on. Either Normal or Low range can be selected in configuration. OV is for regulators only.

LED #	Blinks	Ranges 0-4 4-cell Ni		Range 5 / 6 4.9 - 5.5 reg		Range 7 / 8 5.5 - 6.1 reg		Range 9 6.7 - 7.0 reg		Range 10-15 5c Ni / 2c A123		Range 16-19 2c Li	
		Norm	Low	Norm	Low	Norm	Low	Norm	Low	Norm	Low	Norm	Low
Red 8	2	3.8	3.4	3.8	3.4	4.0	3.6	4.8	4.4	4.8	4.4	5.8	5.4
Red 8	1	3.9	3.5	3.9	3.5	4.1	3.7	4.9	4.5	4.9	4.5	5.9	5.5
Yellow 7	2	4.0	3.6	4.0	3.6	4.2	3.8	5.0	4.6	5.0	4.6	6.0	5.6
Yellow 6	2	4.1	3.7	4.1	3.7	4.3	3.9	5.1	4.7	5.1	4.7	6.1	5.7
Yellow 6	1	4.2	3.8	4.2	3.8	4.4	4.0	5.2	4.8	5.2	4.8	6.2	5.8
Green 5	2	4.3	3.9	**OV** 5.6 / 5.9		**OV** 6.2 / 6.5		**OV** 7.4		5.3	4.9	6.3	5.9
Green 5	1	4.4	4.0	—		—		—		5.4	5.0	6.4	6.0
↓ **Extended PLV** is displayed for 5 seconds IF the channel connected to VoltMagic is toggled quickly 5 times AFTER 1 minute of run time													
Green 5	2	4.5	4.1	4.3	3.9	4.5	4.1	5.3	4.9	5.5	5.1	6.5	6.1
Green 5	1	4.6	4.2	4.4	4.0	4.6	4.2	5.4	5.0	5.6	5.2	6.6	6.2

TABLE 3: Glitch (or Failsafe) Event Counter – Glitch (or failsafe) counting is enabled after one minute, unless connected somewhere without servo pulses. After a bad or missing pulse, any more within 2/3 second are counted as the same glitch. If LED 1 is displaying averaged voltage (AV) also, it will blink off instead of on.

Number of LED 1 Blinks	Glitch or Failsafe Count
1	1
2	2 to 3
3	4 to 7
4	8 to 15
5	16 to 31
6	32 or more

Averaged Voltage (AV) is shown by which one of the 8 LEDs is on. The LEDs are in 0.1 volt increments per the range configured (see Table 1).

Sudden changes in voltage from servo movement are filtered out for a steady reading. **Note:** If connected downstream of a voltage regulator, the voltage output of the regulator will be monitored, not the battery voltage.

PLV is shown by **blinking** LEDs 5 - 8 (see Table 2).

Note: If the same LED indicates **AV**, it will blink off instead of on for **PLV**.

Examples: 5.45 to 4.75 AV, normal PLV (default config)

LED 3 on	Voltage = 5.25
LED 3 on LED 5 blinks once	Voltage = 5.25 PLV = 4.4
LED 5 on LED 5 blinks (off) twice	Voltage = 5.05 PLV = 4.3
LED 8 on LED 6 blinks twice LED 1 blinks twice	Voltage = 4.75 PLV = 4.1 2 to 3 glitches counted