Electronic Circuit Breaker System

VP-100

Operating Manual

April 30, 2010

Current as of
software version 21.1

Table of Contents

1 Introduction

This VP-100 Operating Manual contains information about how to use the system. Information regarding setup and test can be found in the VP-100 Installation Manual. We recommend you become familiar with the material contained in this document before wiring and flying your aircraft.

This manual is based on the software version shown on the cover. It will be revised to reflect additional features as they become available in future software releases.

Two basic aircraft electrical configurations are supported, and are called out specifically when differences exist.

1.1 Table of Revisions

Change date	Change
	Initial release
10-20-09	Added v20 features. See release notes on web.
11-4-09	Added Backup On alarm description.
3-15-10	Added dimming and new method to clear faults.

1.2 Hardware Overview

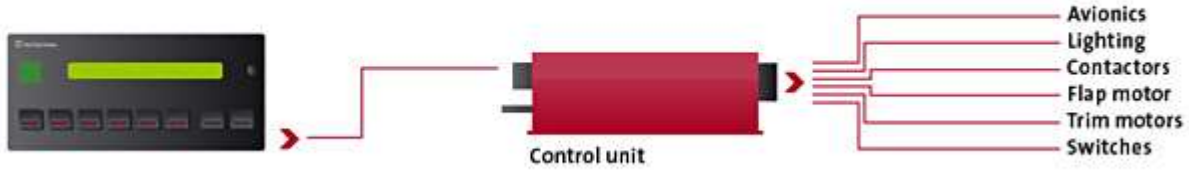
The VP-100 consists of three components: the Control Unit, Switch Panel, and remote key fob.

Switch Panel (SP): This unit mounts in the instrument panel. The screen provides electrical system status information and setup information. The unit has a switch for system power (equivalent to the master switch) as well as eight other switches that can be configured (via set-up screens) to control the electrical devices. Stick-on labels are included to label the switches. Each switch has a built in LED light to provide status and/or alert information to you. An ambient light level sensor is recessed in the bezel. The acknowledge button is used for alarms and for the setup screens.

Control Unit (CU): The central component of the VP-100 is hidden from view and discussed in detail in the VP-100 Installation Manual. It is powered directly from the battery and alternator(s) and powers devices controlled by the VP-100. The CU supplies power and communicates with the Switch Panel through data cables.

Remote key fob: Used to turn on the VP-100 remotely. Future software release will allow you to control electrical devices such as the cabin light or external lights using the key fob. The receiver and antenna are located on the CU. The CU and one or more remote key fobs are uniquely associated with each other using secure encryption technology.

The Control Unit and Switch Panel are connected via data lines as shown.



The pictures below depict the actual screen and the representation of that screen as depicted in this manual:


```
13.5V  0.5A OK
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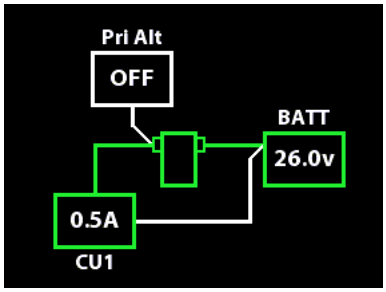
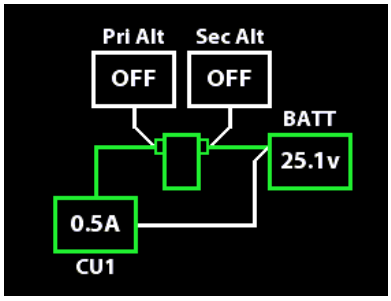
1.3 Electrical System Configurations

The VP-100 supports two different electrical configurations, shown below. Once set up for a certain configuration, the VP-100 then knows how to control the electrical system. If you change your electrical system (for example, add an additional alternator to configuration 1), make sure you go in to the setup screens and change the configuration.

Configuration 1
Single battery
Single alternator, single bus
Single Control Unit



Configuration 2
Single battery
Dual alternator, single bus
Single Control Unit



Additionally, you can monitor the voltage of an independent aux battery.

1.4 System Description

This section describes the user interface components of VP-100.

1.4.1 Remote Key Fob

Press the center button to turn on the VP-100. The outside buttons will be configurable in a later software release.

Be sure that your remote is uniquely associated with your Control Unit. More information is available in the VP-100 Installation Manual.

1.4.2 Switch Panel

The VP-100 includes most of the switches needed to control the electrical system on your aircraft. External switches may be installed to control the flaps and trim, or you can use the built-in switches.

An external starter switch and, if needed, external magneto switches are also installed separately from the VP-100.

The switches on the Switch Panel are identified throughout this manual using the following identifiers:

S1 — This is a three position switch with positions ON-OFF-ON. The switch is ON when the switch is either up or down, and off when it is in the middle position. This switch is designed to control the alternator fields, and can also be used to switch avionics and other electrical devices.

S2 – S6 — These are two position switches with positions ON-OFF. The switch is on when the switch is up and off when the switch is down.

S7 – S8 — These are momentary action switches with positions (ON)-OFF-(ON). They can be configured for wig-wag, device on-off, flap or pitch trim operation.

ACK — This is a momentary pushbutton used to acknowledge alarms and navigate screens.

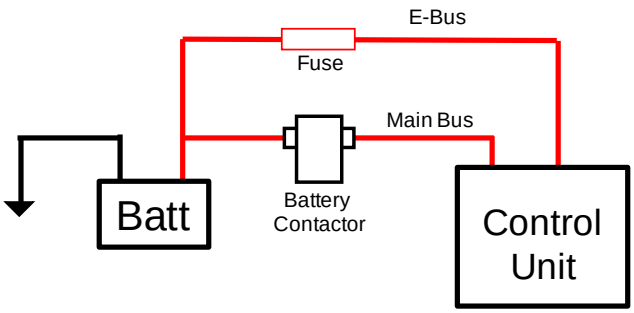
1.5 Alternator Operation

The VP-100 is designed to operate one or two alternators. The alternator is "operated" by providing bus voltage to the alternator field wires (either directly to the alternator or to a voltage regulator).

The alternator is controlled by switch 1. In the up position, the primary alternator is on, and in the down position, the secondary alternator (if installed) is on. Both alternators are off in the middle position. There may be avionics assigned to switch 1 as well.

1.6 Power Bus Architecture

The VP-100 Control Unit has two power inputs from the battery: an endurance bus (e-bus) circuit and a main power bus circuit.



The e-bus provides constant power from the battery for system start, remote key fob receiver power, keep-alive circuit power, and operations under low current loads. The e-bus circuit is protected by a 20A slow-blow fuse; therefore, the VP-100 limits continuous loads to a maximum of 12A. This allows transient loads like the flaps and trim to operate and not exceed the current rating of the fuse.

When the VP-100 turns on, the battery contactor is closed and remains closed. If the battery contactor fails for three seconds, power is switched to the e-bus.

1.7 Electrical System Care

In order to keep your electrical system operating reliably and safely we recommend certain preventative maintenance and operating techniques. This list is not all-inclusive and should be supplemented by items specific to your aircraft.

- Replace the battery every two years during the annual condition inspection. If you have dual batteries, alternate replacing a battery each year. This will ensure strong engine starting and expected endurance times if running without an alternator. Don't wait for the battery to show obvious signs of degradation.
- Do not take off with a drained battery, or "jump start" your airplane and expect the alternator to charge the battery. Make sure your battery is fully charged prior to each flight,

especially after prolonged periods of non-use. If an emergency occurs while airborne and the battery is not fully charged, your battery-only endurance time as well as operations on the primary or backup alternator will be degraded compared with a fully-charged battery.

- Regularly check wires and cables for chafing and other damage. Check that connectors are secure and insulation is good. Wires in the engine compartment are easy to check whenever the cowling is off.

1.8 First Flight

If you are installing the VP-100 in a newly-built aircraft, be sure to read the first flight considerations in the VP-100 Installation Manual. Make sure you are familiar with and have completed the ground test procedures in the VP-100 Installation Manual before flying the aircraft.

1.9 Ongoing Maintenance

The connectors should be inspected during the aircraft's annual condition inspection. Make sure that the thumbscrews on the d-sub connectors are snug, and that the power connectors are inserted fully and latched.

2 System Operation

This section describes how to turn on the VP-100 and the electrical devices on the aircraft.

2.1 Power on & main screens

Turn on the VP-100 by pressing either the green master switch or by pressing the center button on the remote key fob.

After turning off the VP-100, wait at least 3 seconds before turning the system back on.
This short delay gives the electronics time to discharge and clear properly.

The battery contactor closes when the system powers on. If the starter solenoid is failed closed, then the propeller may rotate. **Be sure the propeller area is clear and the door/canopy is open before turning on the system with the remote key fob.** An upcoming software release will detect this failure mode and open the battery contactor.

The system performs a series of checks to ensure that the Switch Panel and Control Unit have the same application version and configuration data, and that the data is valid. If the application is different on each component, the startup process stops and you must reinstall the application via a laptop. If the CU configuration is different from the Switch Panel configuration, it asks if you want to push the configuration out to the Control Unit.

Cycle power to the VP-100 to see if the fault clears, if not, follow the instructions on the screen.

See the Troubleshooting section for fault details.

If any of the trim switch inputs are active (ie a trim switch pressed) during startup, the trim circuit shows a fault. You must clear the physical fault (either a stuck switch or shorted wire), then cycle power to the system to clear the fault in the system.

The system status screen appears at startup.

The screen shows bus voltage, current draw through Control Unit, and status. The status shows:

OK	no faults
1 or other number	number of faults in the fault queue

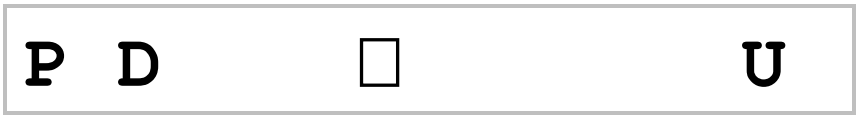
If an aux battery is monitored, the screen shows both battery voltage, the main battery is first and the aux battery is second:

The screen below shows two faults in the fault queue.

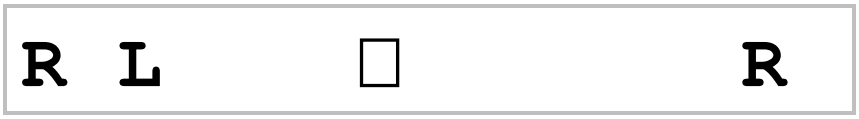
Press the ACK button to cycle through the following screens on the display:

1. System status
2. Pitch trim indicator (if enabled)
3. Roll trim indicator (if enabled)
4. Flap position indicator (if enabled)
5. Fault queue – any faults that are in the queue are displayed, listed in order of occurrence

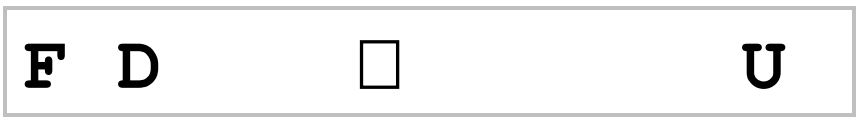
Pitch trim indicator



Roll trim indicator



Flap position indicator



2.2 Power off

Turn off the VP-100 by holding down the green master switch for three seconds.

When the VP-100 is powered off, the Control Unit remembers the on/off state of each pin. It takes about two seconds after power on for the CU and Switch Panel to synchronize, during which time the CU turns on to the state it was in when powered off. If you turn the system off with any of the switches in the on position, the respective devices will come on when the system is turned back on, even if the switches are now off.

2.3 Turning electrical devices on and off

Devices can be turned on or off using the switches on the switch panel. Up is on and down is off. The middle position on the switch 1 is off.

If external switches are installed, they can be used to turn devices on and off.

Switches 7 and 8 can be used for dimming.

2.4 Trim and flap operation

Depending on how they are configured, the flaps move only when the flap switch is pressed or move to the next down position (and all the way up) with a momentary press.

Whenever the flaps are running, the display changes to show the current flap position.

The trim operates whenever a trim switch is pressed. The pitch trim operates at a two different speeds, which are controlled by wither an airspeed switch or a flap position switch or by the position of the flaps.

Whenever the trim is running, the display changes to show the current trim position for that axis. When the pitch trim motor is running at normal speed, the pitch trim position indicator is a square box. When the pitch trim motor is running at slow speed, the pitch trim position indicator is an asterisk.

2.5 Runaway trim and flaps

Runaway trim or flaps can be caused by a stuck switch, a shorted wire, or various other causes.

If you discover the trim or flaps running un-commanded, push and hold the opposite button to immediately stop the motor. The input switch pairs are as follows:

Pitch trim:	up	down
Roll trim:	left	right
Flaps:	up	down

After 3 seconds, the affected circuit faults and you can release the button. A faulted circuit does the following:

- The input switches for the faulted axis are disabled
- An alarm message is shown on the screen

For example, if the pitch trim begins to “run away,” hold down the opposite pitch trim switch (a natural reaction, by the way) until the fault shows on the screen. When it does, the switches are disabled.

A future software release will allow you to use switch 8 as a backup pitch trim switch when the runaway trim fault is active on the screen.

If any of the trim switch inputs are active (ie a trim switch pressed) during system startup, the trim circuit shows a fault. You must clear the physical fault (either a stuck switch or shorted wire), then cycle power to the system to clear the fault in the system.

2.6 Landing Light Wig-Wag

Depending on how the system is configured, one or two landing/taxi lights can be configured to pulse (wig-wag) when turned on.

Either switch 7 or 8 can be configured to set these lights to either steady (on) or wig-wag.

To wig-wag, turn the lights on, then momentarily press switch 7 or 8 (as configured) UP to wig wag or DOWN to go steady. The last state is remembered, so if the lights are turned off when wig-wagging, they will start wig-wagging automatically when turned back on.

When first turned on, the lights will remain in a steady ON state for the specified warm-up time period, then begin wig-wagging. Wig Wag is indicated with a WW on the main screen.

2.7 Switch light indicators

Switches 1 through 6 have an LED light in the tip of the switch. The indicators are as follows:

Off	the switch is off
Green	the switch is on
Red	one or more of the pins assigned to the switch is faulted. You can find the fault in the fault queue if you’ve already acknowledged the fault.

The master switch is lighted green when power is on. A red LED in the switch makes the switch appear red when a fault occurs. The red light works in parallel with the external master warning light, if installed.

Switches 7 and 8 and the ACK button are not lighted.

3 Load Shedding

The objective of load shedding is to reduce electrical loads to extend battery time and/or stay below the rated current of the backup alternator.

Load shedding is accomplished on the VP-100 by turning off switches for loads that you don't want. We recommend that the avionics you want on during load shed are assigned to switch 1, and the ones you don't want on are assigned to switch 2 through 8. That way, you can simply move switch 1 from the primary alternator to the backup alternator, and then turn the other switches off.

When a battery contactor failure occurs, the VP-100 automatically switches to the endurance bus. It will automatically turn off all the pins except those powered by switch 1 (you can turn switches 2-8 back on afterwards if necessary, so long as they don't exceed the current limitations of the e-bus). The actual load on switch 1 should not be set to more than 15 amps (or you risk blowing the e-bus fuse).

The load shedding switch configuration can be changed (via the setup screens) later during the flight test phase based on actual flight testing.

Load shedding is typically started when a low voltage condition occurs. When your primary alternator fails, the bus voltage drops below a pre-set alarm level, at which time the low voltage alarm is activated.

You can fine tune the load shed by further turning devices on or off manually.

4 Electrical Faults

Beyond advisories, the VP-100 will not automatically respond electrical malfunctions unless you command it to do so. This is an intentional design point so the pilot retains the ability to make those decisions based on the situation at hand.

However, the VP-100 does respond automatically to certain faults that require resolution faster than the pilot is able to respond. The VP-100 responds automatically to short circuits, an overvoltage condition, battery contactor failure, and e-bus failure. These are covered below.

4.1 Circuit faults (short circuit, over-current, and current faults)

A circuit fault can be caused by the following conditions:

- Short circuit: the wire is grounded, either momentarily or permanently
- Over-current: the electrical load exceeds the circuit breaker value
- Current fault: the device is drawing no current for three seconds when turned on.

4.2 Clearing a fault

When a fault occurs, it appears on the screen, the power light turns red, and the master caution light comes on.

A fault is shown with the circuit name first, then the type of fault:

When the fault is displayed on the screen, you can:

1. Acknowledge the fault by pressing the ACK button. This places the fault in the fault queue. The circuit remains off.
2. Press and HOLD the ACK button for 2 seconds to reset the fault.

To view a fault that is in the fault queue, scroll to the fault queue (from the main status screen) using the ACK button. A maximum of 32 faults are stored in the queue. When a fault is displayed, you can:

1. Press ACK to cycle to the next message in the queue
2. Press and HOLD the ACK button for 2 seconds to reset the fault.

4.3 Low-voltage alarm

If the bus voltage drops below the configured low voltage level for 5 seconds, then a low voltage alarm is activated.

An alternator failure or voltage regulator failure is normally detected by a low voltage condition. The low voltage alarm will not automatically initiate an electrical load shed. This event must be initiated by the pilot.

4.4 Over-voltage protection

The VP-100 detects when an over-voltage condition exists on the bus, as configured in the setup screens. An overvoltage condition generally occurs because either the voltage regulator or alternator have failed in a manner that allows the alternator to produce higher voltage levels than normal.

You can reset the faulted alternator circuit in the same way you reset any other faulted circuit.

Because the alternator circuit is disconnected, you will shortly get a low-voltage alarm. When this happens you can switch to the backup alternator.

4.5 P- bus/battery contactor failure

If the battery contactor fails, power will be lost on the main power bus (P-bus) from the battery. The VP-100 detects this loss of power and automatically switches to the e-bus circuit, which is powered directly from the battery. When it switches to the e-bus circuit, all electrical devices are turned off except those assigned to switch 1. You must then manually turn on each device you want on.

The primary alternator (as designated in the setup menu) is automatically turned off to preclude a possible over-voltage condition.

The changeover to the e-bus takes one second, during which time avionics will hut off (unless they are on their own internal battery or powered via a backup bus).

The e-bus circuit is protected by a 20A fuse, so the VP-100 limits continuous loads to a maximum of 12 amps. This allows intermittent loads like the flaps and trim to operate and not exceed the current rating of the fuse.

The VP-100 can use battery power through the e-bus circuit up to its 12A limit. The VP-100 will protect the e-bus and not allow you to turn on a device that will increase the load above 12A. In determining whether to turn on another circuit, the VP-100 adds the active current draw to the circuit breaker value of the device being turned on. If the total exceeds 12A, the device will not turn on, and an alert message is shown. Note: this may limit your ability to turn on circuits with high circuit breaker values. Turn on critical circuits first.

A battery contactor failure is detected when there is no voltage on the CU power lug, when there should be. This can be caused by several things:

1. The battery contactor itself fails in a manner so it can’t close
2. The cable from the battery contactor to the CU is loose or not attached
3. The cable from the battery to the battery contactor is loose or not attached
4. The wire that controls the battery contactor is loose or not attached

When the VP-100 detects a battery contactor failure, you must turn the system off then back on the clear the fault. Wait until you are on the ground to troubleshoot this issue. Also note that any backup circuits that are on will remain on during a battery contactor failure. See the VP-100 Installation Manual for more details on backup circuits.

4.6 E-bus failure

The e-bus provides initial power for turn-on as well as backup power to the VP-100. When the VP-100 detects an e-bus failure, you must turn the system off, fix the problem, then turn the system back on to clear the fault. Wait until you are on the ground to troubleshoot this issue.

If the e-bus circuit fails while in normal operation (power is being provided via the battery contactor/power lug wire), then:

- The VP-100 cannot be turned on again once turned off.
- An alarm is generated.
- The VP-100 will continue to operate normally and provide power to electrical devices via the main bus (battery contactor).

Some possible reasons for an e-bus failure include a blown fuse, shorted wire, or damaged wire or connector.

4.7 Backup circuits

The VP-100 allows an unlimited number of backup circuits. See the VP-100 Installation Manual for wiring details. Each backup circuit has a protected, non-system source of power wired through an independent switch. If a backup switch is turned off, the VP-100 controls power to the device. Turning on a backup switch powers the device independently of the VP-100.

Select and use the backup capability intelligently. For example, if your attitude reference is one of the backup circuits, you can turn on its backup power when flying in reduced visibility (IMC and/or night) and then have an electrical malfunction and the reference stays powered. Note that certain failure modes exist that, although rare, can fault the entire electrical system – including the backup circuits. Care in the construction and maintenance of your electrical system is the best way to mitigate these risks.

The backup switches will provide power to their respective devices even after the VP-100 shuts off automatically. Remember to turn off backup power after it is no longer needed.

If a backup switch (wired per Method A) is left on while switches 2 through 6 are all off, then the Backup On alarm is displayed.

4.8 Internal system faults

If the VP-100 detects a substantial internal fault or a software "lock up", it will reboot itself in an attempt to restore normal operations. You can reboot the Control Unit or Switch Panel by cycling power to the whole system.

If the Control Unit reboots, you will get a temporary CU Communication Loss error message. The CU takes about 1 second to reboot, and during a reboot the electrical devices will stay in their current state.

In general, if a specific component should fail, the other components should operate normally. For example, the Control Unit will continue to operate (trim and flaps that are on external switches, short circuit protection, overvoltage protection, and contactor management) even if the Switch Panel is inoperative.

4.9 Exceeding maximum current ratings

The VP-100 Control Unit is rated for a maximum of 60A continuous current. As a safety measure, the VP-100 will generate an alert when the current reaches 48A.

When the current reaches or exceeds 60A, the VP-100 will generate an alert.

They system will not shut off any devices, but the high temperatures caused by the high current draw may cause unreliable behavior. The VP-100 has been successfully tested in conditions beyond its published limits, but it is not recommended you regularly exceed the published limits.

5 Options Screens

The options screens allow you to do the following:

- Set the brightness, contrast, and night/day level for the screen
- View the current draw on each individual pin

If a fault occurs while you are in the Options Screens, the master switch and master warning light will flash red. However, the fault will not be displayed on the screen until you exit.

To enter the options screen, press and hold the ACK button for 2 seconds while at least one of the switches 2 through 6 is on. If switches 2-6 are all off, the VP-100 will go into setup instead. You will see:

Use switch 7 to scroll through the screens. Press ACK to select the sub-screens.

5.1 Adjusting screen brightness, contrast, and day/night settings

To adjust the screen settings, scroll to the screen shown here:

Press the ACK button to view the sub screens: brightness, contrast, day level. Use switch 8 to adjust the values for each screen, and switch 7 to scroll to the next screen. Scroll to the save or cancel screen and press ACK to exit.

5.2 Viewing current draw on each device

To view the current draw on an individual pin, scroll to the Device Amps screen, as shown here:

Press the ACK button to view the sub screens. Use switch 7 to scroll through each assigned pin on the Control Unit. Each screen shows the connector, pin, pin name, and current draw from that pin.

The screen below shows connector J6, pin 5, LAND (landing light) is drawing 2.6 amps.

Scroll through all the pins to get to the exit screen. Press ACK to exit to the options screens. Using switch 7, scroll to the exit screen to exit the Options screens and go back to the system status screen.

6 Software Updates

Software update procedures can be found in the VP-100 Software Release Notes in the support section of the web site.

7 Troubleshooting

The following issues may happen during normal operation. Additional troubleshooting and configuration information is available in the VP-100 Installation Manual.

System won't turn on.	1. Check that each d-sub cable is secure, no pins are bent. 2. Verify all power connectors are secure. 3. Verify power to the e-bus wire and that the e-bus fuse is not blown. 4. Check the ground wiring. The CU has three ground wires.
Flap faults during operation	1. Check circuit breaker value. Flaps draw more power when under load than when on the ground.
Fault codes on startup	Chk Cable/CU ID a) Check the cabling and/or the CU ID switch. The Switch Panel can't talk as expected with the Control Unit. No CU Response a) The CU did not respond to the Switch Panel as expected. Check the cabling Reload Software a) There was a software mis-match. Run the SW Update Application and update the software. Please Import a) There was a database error on the Switch Panel. Load your settings using the SW Update Application. Update CU a) There was a key mismatch between the Switch Panel and Control Unit. Update the CU settings from the Switch Panel by pressing the ACK button.